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THE INSECTS OF A LONDON BACK-GARDEN.—I.

By Fred. Enock, F.L.S., F.E.S.

IF there is one thing above another which impresses itself upon the mind of a stranger coming up from the country, surely it is the view of the London "backs," as seen from the carriage windows, when the train threads its way through the crowded suburbs. From some of these London "backs" I have derived much pleasure in studying the creeping and flying things found in such places—things which country people scarcely ever see (because they never *look* for them), and thus our knowledge of insects is chiefly derived from the work of town naturalists.

London back gardens vary considerably in length, but thirty feet is about the average. In such a "back" I have found creeping things innumerable—some altogether new to science. This may be owing to the encouragement given to insects to come and congregate where they will be looked after! The first appearance of a new garden is not prepossessing—a square of grass, termed a *lawn*, surrounded by a narrow pathway covered with coarse burnt-ballast, and a narrow strip of ground into which it is not advisable to dig to a greater depth than six inches, unless we are desirous of starting a museum of present-day kitchen utensils, together with various types of foot-gear. The first and best thing to do is to endeavour to raise a background at the end of the garden. This is easily managed by utilizing the wisps of willow with which bundles of rhubarb are bound up in April. A dozen of such cuttings put in and well watered will soon strike and grow up quickly, and become peopled with all sorts of insects during the first year. The well-known green fly or "blight" is only too plentiful, and every flower and shrub has its peculiar kind, whose identity can easily be ascertained from Buckton's "British Aphidæ" (Ray Society). The prodigious rate at which these mild-looking insects increase is almost past our conception, and certainly few people believe it possible. Nevertheless it is a fact that but for the army of parasites whose larvæ feed inside the green flies, while those of other flies feed direct upon the blight, so keeping a constant check upon their undue increase, they would so multiply that every green leaf would soon be consumed.

Our knowledge of these benefactors is very small indeed, and yet nothing can be easier than the breeding of new species. All that is necessary is to carefully collect the largest aphids, placing them in a phial with a label having the date and name of flower or tree from which the flies have been taken. In a few days or weeks the parasites will emerge, when they should be killed, set on card, and carefully numbered—a corresponding number being kept in a diary, with all particulars concerning the date of emergence and the plant from which the aphis had been taken. Such a work, systematically carried out, would be of great scientific value.

It is most interesting, on a bright, sunny morning, to watch one of these busy little parasites, such as *Aphidius*, at work among a swarm of *Aphidæ*. Settling upon a leaf, it at once proceeds to sound the first "fly" with which it comes into contact by tapping it upon its back with its long antennæ—those sensitive organs through which is conveyed to the brain the knowledge that the green fly is or is not a suitable one wherein to lay an egg. If the aphis does not already possess an egg in its stomach, the parasite leaps upon its back, holding on with a firm grasp with its tiny bifid claws. The point of the ovipositor is quickly brought down upon the back and a hole drilled through, in spite of the resistance of the aphis, which is compelled to take in a lodger. This egg soon hatches to a maggot, which feeds upon the juice contained in the stomach, so stimulating the appetite of its host, which increases in size until it is ready for its next change to the pupa. But while it has been growing, the internal parasite has been doing the same, and has almost reached its full growth. The aphis has not strength to go through its change, so, spreading out its legs, it takes a firm hold on to the leaf and dies, and the parasite completes its growth by feeding upon the remaining juice. The host's body then becomes hard and dry, retaining its distended form. In the course of a week or more the parasitic larva changes to a pupa in the stomach of its dead host, or hostess (generally the latter); and on arriving at maturity, which it does upon its back, with the head towards the tail of the aphis, it commences to bite an aperture through the dried skin. Moving its head round on its neck, it cuts out with its sharp teeth a small circular piece. Its head is soon thrust through, followed by the first pair of legs; then the antennæ are freed one by one—next the second legs are carefully withdrawn, and a firm hold obtained on the skin of the late hostess. The wings are gradually worked out a short way, followed by the withdrawal of the third and last pair of legs; the wings are then easily completely withdrawn, quickly followed by the abdomen, which at first is much distended, but after the discharge of fluid it soon assumes its natural shape; the

wings quietly (and what a charm there is in this mysterious quietness!) expand, and the legs are brushed one over the other until freed from every particle of the delicate pellicle,

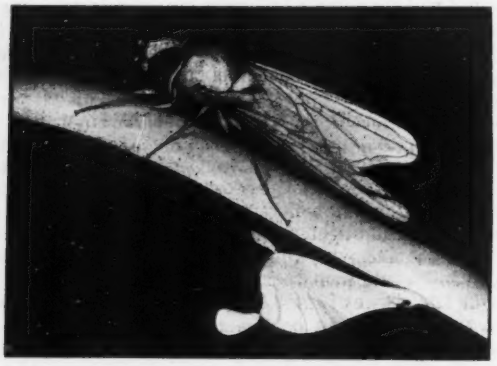

FIG. 1.—Empty Pupa Case and Wasp Fly (*Syrphus*).

and they are fit to comb the antennæ and arrange every sensory hair in its right place. Lastly the wings are delicately brushed down until the entranced observer almost fancies he can see the soft blush of colour stealing over the membrane; then a sudden movement of the antennæ denotes that the work is done, and as the creature walks along in its virgin beauty the light plays on its wings in an endless variety of tints.

Countless numbers of *Aphidæ* never reach maturity, owing to the relentless attacks of the larvæ of the common ladybird beetle, which is, without doubt, one of the most beneficial of all insects; though at one time, not very far distant, it was looked upon as a blight! But now, even some of the British farmers regard it as their friend. The larva works a great deal completely out of sight, hidden away in the distorted leaves of the apple tree suffering from "the blight," where, surrounded by these bloated creatures, the

FIG. 2.—Willow Saw-Fly (*Nematus gallicola*).

busy ladybird lays a patch of sugarloaf-shaped, yellow eggs, from which the sooty-coloured larvæ soon emerge to commence their work of extermination. In ten or twelve days they are full fed, and attach themselves by the tails to the leaves, and change to a shrivelled-looking chrysalis. Sometimes more than a dozen of them may be found in a single curled-up leaf.

Another most useful larva is that of the lovely golden-eyed, lace-wing fly *Chrysopa*, which, with its long and curved jaws, makes short work of every "green fly" with which it comes into contact. The perfect fly continues the work of destruction; but it is as well not to handle this lovely lace-wing fly, as it has a habit of giving out the most abominable odour—no doubt as a means of defence. The delicate green eggs, fixed at the ends of silken threads, are objects of great beauty and interest. Seated on a leaf, the lace-wing affixes from the tip of her abdomen a small pad of "silk"; then, drawing her body away from the leaf or stalk, she stretches a short thread, the oval egg being laid at the end. The abdomen is again brought down on to the leaf, a fresh foundation made, the silk drawn out to the same distance, and another egg laid at the end. This operation is continued until a dozen or more stalked eggs are laid; but, in spite of this wonderful protection, they sometimes fall a prey to a prowling earwig. I have not yet bred any parasite from these eggs, though I expect to do so.

FIG. 3.—Saws of *Nematus gallicola*.

Of all the beneficial larvæ to be found in a garden, not one can compare in importance to those of the various kinds of wasp flies; and yet how few gardeners know this larva, the rose grower's greatest friend.

Observers of insect life know that this wasp or hoverer fly is in the habit of depositing an egg or two on leaves and stems where the *Aphidæ* are feeding and breeding. These oval eggs are pure white, about a fiftieth of an inch long. Some of the shells are embossed all over with delicate

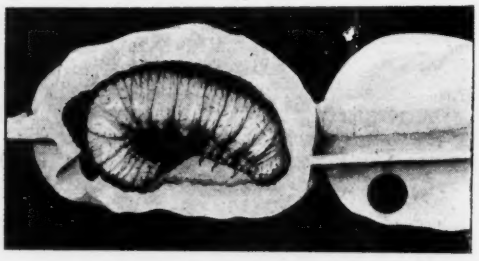

FIG. 4.—Section through Willow Gall, with Larva of Saw-Fly.

markings, while others are studded with minute projections not unlike silver nails, with exquisitely chased heads—grand objects when seen in the microscope with an inch objective. In three or four days, from each egg is hatched a tiny maggot-shaped larva, which even before it has fully escaped from the shell commences to wave its little body about, not unfrequently touching an aphis, which it

immediately sucks dry. This first taste of food whets its appetite, and it hurries out of its eggshell, to walk abroad among the horde of *Aphidæ*, among which it soon makes a clearing, and quickly increases in size, until in a few days it becomes a grub of about three-eighths of an inch long, having an attenuated body, a small hook-shaped mouth, a pair of anal claspers, the tail end being much thicker than the head. Its favourite habit is to affix itself by the claspers to a midrib, or any projection on the under side of a leaf. Here it waves its body to and fro, pitching upon some aphis, which it immediately seizes and hoists up into mid air, where it sucks out every minute drop of fluid, until only the whitened skin remains. This is flipped away. The larva immediately takes up another aphis and sucks it dry, flings it away, and again repeats the process, until its rapacious appetite is appeased. A good healthy larva can easily destroy from one hundred to *one hundred and twenty green flies in one hour!* So that, during its life of ten to thirteen days, some thousands of *Aphidæ* are destroyed. When full fed it retires to a twig, dead leaf, or out-of-the-way spot, on which it firmly fixes itself by the anal claspers; the attenuated body shortens, and widens tremendously at the head until it becomes quite pear-shaped (Fig. 1); the skin hardens, forming the protective covering to the maturing fly, whose markings, as they reach perfection, can be easily seen through the semi-transparent skin. A transverse suture appears a short distance from the thick end, denoting the near appearance of the fly, which, in the course of a few days, splits this lid vertically and horizontally, and by muscular effort quietly rises from between these two small lids, which swing back on the most delightfully contrived hinges. The large compound eyes of the wasp fly occupy almost the entire head; then legs are gradually drawn out, and as soon as the first and second pair are free, the fly takes hold of the stem or leaf and lifts itself right out of the pupa case, which is left adhering to the stem, while the fly walks round to the under side, where it hangs by its claws until the fluid has permeated the wings, when it gently takes its first flight, hovering quietly over the flowers in search of its mate. The nuptials over, if a female the business of its life commences, and it quickly distributes its eggs over the aphis-infested plants, and, its mission and purpose fulfilled, it dies.

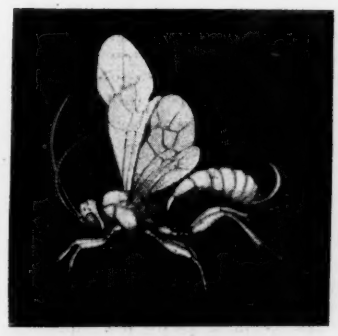

Fig. 5.—Parasite of Willow Saw-Fly.

One of the most interesting inhabitants of a London "back" garden provided with willow trees is the willow-gall saw-fly. Everyone without exception must have noticed the willow leaves in June bespangled all over, front and back, with these pretty, bright, crimson-coloured little galls—but very few appear to care to inquire into their origin. Some of our scientific men are in doubt as to the insect which is the cause of them—it is astonishing with what tenacity such cling to their books, instead of going direct to nature. Of course, a three-volume "work" can be read in a few days, but year after year may roll by before the secrets of the life-history of a common insect are observed and confirmed; but, as a correspondent wrote to me the other day, "the study of the life-histories of insects is so enthralling that one is astonished that people have time for reading so much that is unprofitable."

Now, let us follow out the life-history of this willow gall, which makes its appearance on almost every willow in the country, as well as in the heart of London. It is the willow saw-fly (*Nematus gallicola*) which is the cause of it. At the present time (April and May) the females of this fly are engaged in laying the foundation of the galls. In Fig. 2 the saw-fly is seen resting on one of the young leaves, on which is to be seen a number of minute slits; these, as well as those on the half-expanded leaf below, denote the small slits made by the ovipositor, which is formed exactly like a most perfect tenon saw, having exquisitely formed compound teeth. Each kind of saw-fly has totally different teeth, which form admirable characters for classification. For the number and names of saw-flies see Mr. Cameron's "British Tenthredinidæ" (Ray Society). This wonderful organ not only serves the purpose of a saw, but also that of a perfect tubular ovipositor, the two blades and tenons being so wonderfully "rabbetted" together that from being almost a flat saw it can be so expanded as to permit of an egg passing down and being conducted to its nidus between the upper and lower cuticle. Fig. 3 shows this organ dissected to display the various parts, all of which, when out of use, are carried in the sheaths above. Immediately the egg is laid the fly withdraws her ovipositor, turns round, and applies her mouth to the minute slit, which she seals with saliva.

I have frequently counted between twenty and thirty galls on a single willow leaf. A few hours after the eggs have been laid, a change in the colour of the leaf takes place, and a rapid growth resembling a small pimple commences, which, in a few days, increases to a gall of about three-sixteenths to a quarter of an inch in diameter, swelling out from both surfaces of the leaf—that on the upper gradually assuming a most brilliant crimson colour. The lower part is not so decided in colour.

Some authorities state that the egg hatches almost immediately—before the gall is formed—but such has not been my own experience, as I have repeatedly cut open galls of three days' growth and found the egg in the centre, and not until the fourth day have I found the young larva. The first food taken by the occupant is from the cellular structure of the gall, from the centre of which to the under side a small tunnel is eaten out. This serves the purpose of

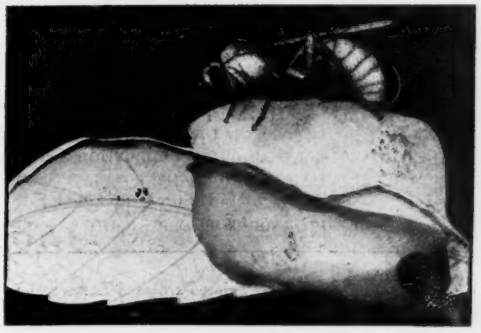

Fig. 6.—Parasite of Willow Saw-Fly piercing Gall.

a channel and ventilator—all waste material falling out at the aperture, which is increased in size when necessary. The growth of the larva is somewhat slow, and though the

galls are so plentiful the perfect insects are very scarce. I have never yet bred a specimen of the male. At birth the larva is quite white, but in the course of a few weeks becomes a delicate apple-green, the head large and rounded, having a few dark markings at the sides—the body much

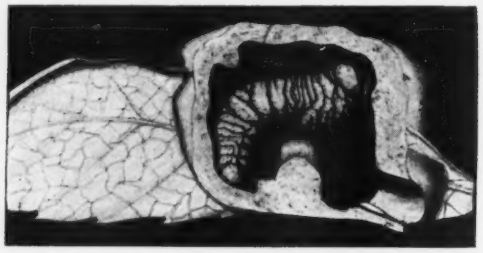

Fig. 7.—Section of Gall, showing Paralyzed Larva and Egg of Parasite.

wrinkled, the anal segments curved down and rounded (*see* Fig. 4). When full fed the larva is a quarter of an inch long, and such as have managed to escape the attacks of innumerable parasites and predaceous insects eat their way out through the channel on the under side, crawl down the leaf stem and branch, or not unfrequently tumble down to the ground, in which they spin a small brown-coloured cocoon. Others crawl down the trunk, and, if possible, spin their cocoon at the back of some loose bark, where frequently many of the cocoons can be found clustered together. These are easily collected, and in due time saw-flies and various parasites are bred. The latter are more numerous. The first broods of saw-flies emerge in April and May, the second in the latter part of autumn, when the willow is throwing out a second growth of terminal leaves.

A lifetime would hardly be long enough in which to study and write out the life-histories of the various insects which I noticed frequented the willows in my little back garden, but one or two of the parasites of the willow saw-fly may be noted. One whose identity I have not yet decided is, perhaps, one of the most interesting. I first observed this beautiful parasite flying around the willow leaves during the first week in June, but on capturing one I noticed that it had a most peculiar "curly tail"—or, rather, the sheaths of the ovipositor were curved in almost a semicircle—and how this could be brought down on to a semicircular gall

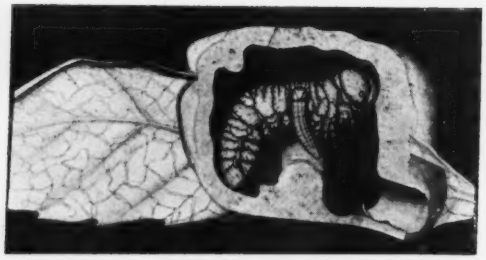

Fig. 8.—Section of Gall, showing Paralyzed Larva and Egg and Larva of Parasite.

I could not at first understand, but after a number of days' observation everything was made perfectly clear.

All *Hymenoptera* love bright sunshine, and that is the only time when saw-flies and parasites are at work. The first are very wary. I found it best to take my stand close to the tree before the sun shone, as any approach was detected at once. In this way I was enabled to observe every movement.

The parasite (Fig. 5) is a small insect a quarter of an inch in length, the male clouded with red and black, whereas the female has no bright colouring. The male always follows the female, most persistently and successfully threading its way between branches and leaves, its sight being simply marvellous. As soon as the honeymoon is over the female quietly hovers around the terminals, and, settling upon a gall-covered leaf, rapidly sounds the first gall. If it contains an occupant, the parasite quickly mounts on to the upper surface of the crimson gall, and in a moment—not longer—her abdomen, with the exquisitely-formed waist, is bent down between the third pair of legs, which absolutely take hold of the sheaths of the ovipositor—the peculiarly-formed hairs on the coxæ holding the long and delicate auger-like organ between them, until the barbed points are pressed into the gall (Fig. 6), when immediately the sheaths and abdomen move back into their original position. By muscular effort the long setæ are driven through the walls of the gall, and right into the body of the larva of the saw-fly, and, after the parasite has repeatedly stabbed and injected small drops of formic acid into it, this long auger is withdrawn, and the poor larva

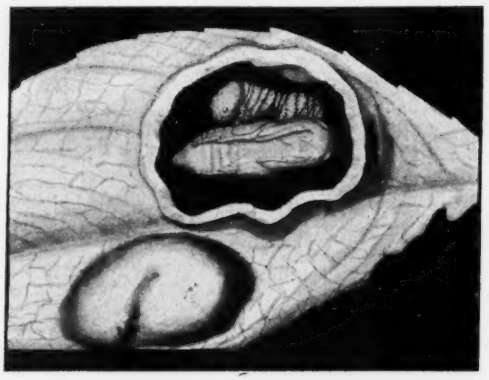

Fig. 9.—Section of Gall, showing Skin of Larva and Pupa of Parasite.

lies paralyzed. After the parasite has replaced its organ between the sheaths, it turns and twists about in a very comical manner for a few moments, then it crawls round to the under side of the gall and inserts its ovipositor. At first my excitement prevented me from discovering its purpose, for, in my endeavour to focus my magnifier, I disturbed the parasite, which flew away, as did several others from the same cause. However, I carefully cut open the galls through which the parasite had driven its setæ, and found that the lovely apple-green larva had changed to a sickly yellow colour—all its activity was gone, and only a slight movement visible.

After repeated failure, I after all managed to watch a parasite insert its ovipositor in the channel on the under side of the gall; the antennæ were closely embracing the gall, and from their tremulous motion I concluded an egg was being laid. A few minutes more, and the parasite resumed its activity. The antennæ were held aloof, and the creature seemed to be "clucking," though in a note which did not reach my hearing. When this was over, away it flew. I quickly, but very carefully, cut the gall down the centre without removing the leaf, and there, on applying the magnifier, I saw the egg (Fig. 7) lying in the channel, an eighth of an inch away from the paralyzed

saw-fly larva. Closing the gall again, I tied it round with thin cotton, examining it each day, until on the fourth I discovered a tiny white maggot in the act of crawling from the egg. Once more I closed it up, but only for an hour or

Fig. 10.—*Eulophus nemati* (female), Parasite of Willow Saw-Fly.

two, for, on reopening it, there was the maggot (Fig. 8) with its jaws fixed tight into the paralyzed larva of the saw-fly, which, as day after day passed, gradually decreased until only the skin remained, whilst the parasitic larva increased. Now, many parasitic larvæ spin a silken covering wherewith to protect them during the change to the pupa, but this one did not require more protection than that of the gall, so no cocoon was made; but the larva laid down on its back close to its food, and there changed to a naked pupa (Fig. 9), to emerge either late in the autumn (I have bred some in October), or, more generally, in spring.

Fig. 10 represents another very exquisite parasite of the willow saw-fly. This is *Eulophus nemati*, a perfect jewel. Though not more than a sixteenth of an inch long, its body is one blaze of flashing colour. The head, thorax, and parts of the legs are pitted all over with minute concavities, which reflect the sunlight in every direction, making it a sight to be remembered. The male (Fig. 11) has the additional charm of most extraordinarily formed antennæ, which take an important part when this handsome couple meet and pay court —which is a ceremony in which much frivolity is shown. Antics of the most comical character are indulged in. These exquisite parasites, together with many others, are exceedingly common, each species showing peculiarities of the most extraordinary kind.

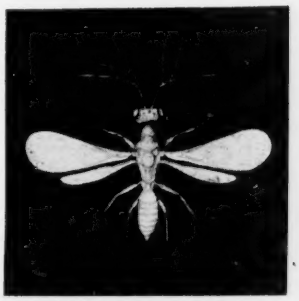

Fig. 11.—*Eulophus nemati* (ma'e), Parasite of Willow Saw-Fly.

I can only recommend those who are desirous of studying insect life in a somewhat limited area to grow willow trees, from which they will obtain an endless supply of insects.

Science Notes.

The South-Eastern Union of Scientific Societies holds its second annual congress at Tunbridge Wells on May 21st and 22nd. Various meetings and excursions will take place during these two days. There are also a number of very interesting papers down for reading by Prof. Boulger, Prof. Seeley, Rev. Scargill, Mr. T. W. Tutt, and others. The congress should prove a great success. Full particulars as to membership, etc., can be had of the hon. secretary, M. G. Abbott, M.R.C.S., 2, Queen's Road, Tunbridge Wells.

A propos of the recent opening of the celebrated Borgia apartments in the Vatican, containing the beautiful frescoes by Pinturricchio, it may not be uninteresting to mention that there is a model of a portion of one of the "stanze" in the South Kensington Museum. It is believed that the construction of this model aroused great interest in the suite of rooms named, with the fortunate result that His Holiness Pope Leo XIII. ordered the books belonging to the Vatican library, until recently kept on shelves placed against the walls of the "appartamento," to be removed, and arrangements made so that the public might have access—a privilege, until now, exceedingly difficult to obtain.

We regret to announce the death of Mr. George W. Traill, the author of several exhaustive monographs on the algology of various localities. In 1885 appeared "The Algæ of the Firth of Forth"; in 1886, "The Marine Algæ of Joppa"; in 1888, "The Marine Algæ of Elie"; and in 1890, "The Marine Algæ of the Orkney Isles." Mr. Traill was a member of many learned societies, and his contributions to the *Transactions* of these bodies were both numerous and important.

The profitable utilization of waste glass is now said to have been accomplished by M. Garchey, a Frenchman. Ornamental objects of many kinds are produced from the great masses of broken glass accumulated at factories, and a building material called "ceramic stone" is among the products derived from this source. The waste glass is first ground and placed in a metallic mould, and it is then introduced into a furnace in order to devitrify and anneal the mass; in this way the molecules weld together and form a consistent dough. The mould is next placed for a few minutes in a second furnace heated to a very high temperature, by which means the devitrification is completed, and the mass rendered very pliable.

M. Berthelot has recently published in the *Comptes Rendus* analyses of weapons, tools, etc., from Tello, in Chaldea. Their date is put from 4000 to 3000 B.C. A large lance and a hatchet were found to be approximately pure copper, and another hatchet was of copper with traces of arsenic and phosphorus, by which it seems to have been hardened. No trace of tin was present in any case. Thus, in Chaldea, an "age of copper" seems to have preceded the "age of bronze." An egg-shaped object from the same locality, weighing one hundred and twenty-one grains, was of iron; an ingot of white metal was ninety-five per cent. silver; a leaf of yellow gold was found to contain considerable quantities of silver.

According to M. Henri Moissan, in a communication to the Paris Academy of Sciences, the deposit made on a diamond by molecular bombardment in a high vacuum, shown by Mr. Crookes in 1879, is undoubtedly graphite, proving that the diamond must attain on its surface a temperature nearly equal to that of the electric arc.

XUM

BIOLOGICAL PROGRESS IN THE VICTORIAN ERA.

By R. Lydekker, B.A.Cantab., F.R.S.

THE reign of Her Majesty will be notable in future generations for scientific discovery and progress, and among the sciences that have advanced by leaps and bounds during this lengthened period, biology must surely occupy one of the most prominent positions. Indeed, it is almost impossible for workers at the present day to realize how imperfect was our knowledge, and how comparatively few were our books on biological subjects, in the year of grace 1837. To give any adequate idea of the amount of progress that has been made in even one branch of this science during the reign, would be manifestly impossible in an article of the present length, and it is hence a matter of extreme difficulty to select points for special mention.

Perhaps one of the best means for indicating progress is to refer to some of the most notable works and serials that have had their beginning during or shortly before the present reign. And here it may be observed that at the time of the Queen's accession, zoology was fettered by the trammels of the "circular" or "quinary" system of classification, which, although originated by W. S. MacLeay, had been exemplified with a marvellous power of clever illustration by Swainson in two volumes published in 1835 as a part of Lardner's "Cabinet Cyclopædia." It is scarcely too much to say that the science was not thoroughly purged from the influence of this mischievous teaching till the appearance of the "Origin of Species" in 1859.

To the present-day zoologist the British Museum catalogues are absolutely indispensable, and he can hardly imagine the possibility of working without them. Nevertheless, the first of these valuable publications appeared in 1837, under the title of "List of Additions to the Collections in the Year 1834," although it was not till 1843 that the first of the systematic catalogues was published. Take, again, the *Proceedings of the Zoological Society*, which now form the most important zoological serial in the world. These only commenced four years before the reign, and it was not till much later that they obtained their present size and importance. Of the publications of the Geological Society, the *Proceedings* date no further back than 1834, while it was not till 1845 that the first number of the now familiar *Quarterly Journal* saw the light. The publications of the Entomological Society date almost from the accession, the first volume of the *Transactions* having appeared in 1836.

Although a couple of monographs appeared in 1832 and 1834, while the "Birds of Europe" is stated to have commenced in the former year, Gould's well-known magnificent series of faunistic works is practically a product of the Victorian age. Much the same may be said of Yarrel's two great works on the British fauna, the first edition of the "Fishes" having been published in 1836; while Bell's "British Quadrupeds" has its "diamond jubilee" during the present year. Even more striking is the case when we turn to palæontology, as we find that hopelessly obsolete work, Buckland's "Geology and Mineralogy" coeval with the reign, while Owen's "Palæontology" did not make its appearance as a separate volume till 1861, although issued two years previously in the *Encyclopædia Britannica*. It is hard, indeed, to conceive how anyone could have acquired even the rudiments of the science when works like these were not in existence.

Of Owen's works the greater portion has appeared during the reign, although his memoir on the mammary glands of the duckbill bears the date 1832. This serves to remind us that the history of the monotreme mammals has been practically worked out during the same period, the discovery that these animals lay eggs not having been announced till the year 1884. Although, owing to his persistent opposition to the doctrine of evolution, his theories of the relationships of animals have not met with acceptation, it is difficult to estimate the debt which zoology and palæontology owe to Owen for his work during the reign. To him is due the honour of making known to the world the former existence of the gigantic extinct moas (*Dinornithidæ*) of New Zealand, and also of the wonderful extinct marsupial fauna of Australia, while he was the pioneer in the elucidation of the equally marvellous fossil mammals of South America. Had these faunas not been discovered and worked out, we should never have gained our present ideas of the geographical distribution of animals. To the same master of anatomy is due the first description of the long-tailed Jurassic bird (*Archæopteryx*) in 1862, the fossil being one of the most remarkable "missing links" ever discovered—too late, unfortunately, for Darwin's "Origin of Species." Although many of his views are now proved to be erroneous, Owen also did much for the extinct Mesozoic reptiles which he well christened Dinosaurs, and his labours laid the foundation for almost all subsequent work on fossil reptiles in general.

The mention of Dinosaurs naturally leads on to Huxley, who, although by no means essentially a palæontologist, was the first to point out the connection between that extraordinary group of reptiles and birds, a line of investigation in which he was ably seconded by J. W. Hulke. The life-work of Huxley was entirely produced during the reign, and how much it contributed to systematic and morphological zoology needs no mention here. One of his most famous memoirs—on the structure of the palate of birds—forms, to a great extent, the basis of the present classifications of the group. But in popular estimation Huxley's greatest claim to recognition is probably his brilliant advocacy of the evolution theory. That doctrine will ever remain the crowning biological achievement of the record reign, and it is no disparagement to its illustrious expounders—Darwin and Wallace—to say that it was only through the unwearied labours of workers in other branches of biology, during and previous to the early part of the reign, that it was possible for them to have weaved the scattered facts and observations into one harmonious fabric.

Although Darwin's name is, in popular estimation, more intimately connected with the doctrine of evolution, that of Mr. Wallace (happily still among us) has obtained a well-deserved fame in connection with the geographical distribution of animals, a branch of biological science which may be said to be almost an exclusive product of the Victorian era. It was in 1835, two years only before the accession, that Swainson published his "Geography and

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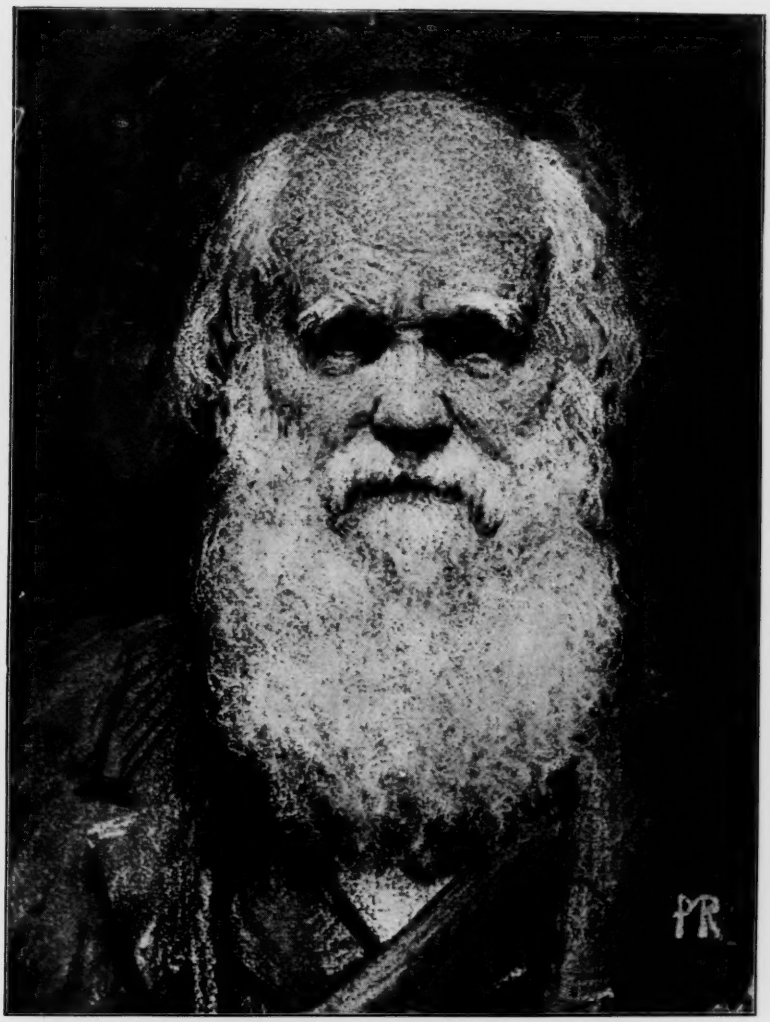

CHARLES DARWIN.

From an Original Drawing by PAUL RAPHAEL MONTFORD.

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Classification of Animals," and from that date till the appearance of Wallace's "Geographical Distribution of Animals," in 1876, this branch of the science was being gradually evolved and perfected. Indeed, both on this and the other side of the Atlantic this interesting and important study is still employing the energies of several workers, although it would be obviously inappropriate to say much in this place regarding the labours of living writers. Evolution and geographical distribution may be regarded as sister branches of biology, as neither could exist without the other, and it is difficult to say which is most indebted to its fellow.

From the subject of the geographical distribution of animals and plants there is a gradual and imperceptible transition to the study of the changes in the relative distribution of land and water which have taken place on the surface of the globe during the later ages of its existence. And although this is in reality a geological rather than a biological problem, it is one intimately connected with the fauna of the ocean abysses. The interesting results obtained by the dredging cruises of H.M. ships *Porcupine* and *Lightning* in the summers of 1868, 1869, and 1870, of which a popular account is given in Wyville Thomson's "Depths of the Sea" (1873), led to the despatch on December 21st, 1872, of H.M.S. *Challenger* on a lengthened dredging and exploring voyage, which was brought to a successful termination on May 24th, 1876, on the evening of which day the corvette anchored at Spithead. The results of this cruise, which were described in a popular manner by Moseley in 1879, revolutionized previous ideas as to the nature of the ocean-bed and the fauna of its abyssal depths, while a vast store of information was acquired with regard to pelagic creatures of all kinds. During the voyage the art of deep-sea dredging and sounding was brought nearly to its present perfection. This and other cruises made during the reign have brought to our knowledge the luminous fishes inhabiting the dark ocean abysses, and they have also revealed the fact that creatures like the sea-lilies (*Crinoidea*), long supposed to be practically extinct, are still abundant at suitable depths in the ocean. The publication of the scientific results of the *Challenger's* cruise commenced in 1880, and has only recently been completed; and if we had no other works to boast of, these alone would form a glorious biological monument for any reign. Nor have other countries been behindhand in similar undertakings; and among French works, H. Filhol's account of the cruise of the *Travailleur* and *Talisman*, published under the title of *La Vie au Fond des Mers*, is one of the most fascinating books it has been our good fortune to read.

Deep-sea dredging is closely connected with the establishment of marine biological stations, and the preservation and breeding of food-fishes and oyster-beds. These two are exclusively a product of the reign, and their importance from both a biological and an economical point of view can scarcely be overrated. Frank Buckland in the first place, and Huxley in the second, have, in this department, well shown how men of the highest scientific attainments can combine the pursuit of their own particular studies with others yielding untold advantage to our fisheries.

An equally close connection exists between deep-sea dredging and the study of the growth of coral islands and coral reefs; a subject entering upon the domain of both zoology and geology. This, too, is a subject whose development has taken place during the Victorian era, Darwin's well-known volume having appeared in 1851, while Dana's "Corals and Coral Islands" was published in 1875. That the last word has not been said in regard to the growth of coral islands is proved by the recent partially unsuccessful boring expedition to the Barrier Reef of Australia, under the superintendence of Prof. Sollas. To the older geologists it would, doubtless, come as a severe shock to learn that our massive Palæozoic and Mesozoic limestones are, to a great extent, merely ancient coral reefs; yet this is only one of the minor discoveries connected with the biology of the reign.

To attempt to give any account of the animals discovered since Her Majesty ascended her throne would obviously be impossible here. Among some of the most remarkable are, however, the gorilla, the potamogale, the water-chevrotain (*Dorcatherium*), the parti-coloured bear (*Æluropus*), the Australian lung-fish (*Ceratodus*), and *Peripatus*, which looks so like a near relative of the primitive stock of all arthropods. The "dark corners" of the earth have been explored and opened up, and the fauna of Tibet and other parts of Central Asia, of a large portion of Africa, of New Guinea, of Central Australia, and of many oceanic islands, as well as the interior of Borneo and Celebes, has been revealed and described. The ornithology of South America has received an especial attention during the reign; while the magnificent *Biologia Centrali Americana* is making known to us the entire fauna and flora of the central districts of the New World. In the classification and morphology of fishes, as also in our knowledge of whales and other marine mammals, great advances have been made; and even books as apparently ancient as Beale's "Natural History of the Sperm Whale" (1839) have been published during the reign.

In embryology and physiology the strides have been enormous, although most of the discoveries in these departments are of too abstruse a nature to be even mentioned here. Von Baer's great work upon the development of animals was indeed completed in the year in which Her Majesty ascended the throne; but the whole of Frank Balfour's investigations and works on this subject are a comparatively late product of the era, his "Development of Elasmobranch Fishes" having appeared in 1878.

Although Cuvier had long previously described the fossil mammals of the gypsum quarries of Montmartre, while a considerable amount of work had already been done on the remains of those from the French and German Tertiaries, most other extinct Tertiary land faunas have been made known since 1837. And what an important part the discovery and description of these faunas and floras have played in regard to our ideas of the evolution of living beings, and also in respect to geographical distribution, needs no telling here. Falconer and Cautley's *Fauna Antiqua Sivalensis*, in which are depicted the extinct mammalian remains from the Siwalik Hills of Northern India, seems to most of us a work of very ancient time; nevertheless, the first part did not appear till 1845, while the last was published in 1849. Gaudry's description of the fossil animals of Attica only dates from 1862, while the discoveries of the extinct mammalian faunas of Hungary, Persia, China, and Samos are still more modern events. Within the last twenty years the working of the phosphorites of Central France for economical purposes, has revealed the existence of a numerous Oligocene land fauna with which we were previously only very imperfectly acquainted. More important than all are the palæontological discoveries which have taken place late in the reign in the Mesozoic and Tertiary deposits of the United States. These have revolutionized many preconceived ideas, and have shown that for the future the most important advances in the structure and history of the higher vertebrates of past epochs must come from the other side of the Atlantic. Not only have entirely new groups of mammals, such as the horned *Dinoceras* and

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Titanotherium, been discovered there, but the remains of dinosaurian reptiles are met with in a state of perfection to which there is no comparison in other parts of the globe. These complete skeletons have not only fully borne out the speculations of Huxley and Hulke as to the close structural resemblance between these reptiles and birds, but have also shown how nearly the restorations attempted by the English anatomists approached the reality. Equally important have been the palæontological discoveries in South America: discoveries which indicate, without doubt, a former Tertiary land connection between that continent and distant Australia. To even allude to some of the palæontological discoveries among the lower groups of animals is obviously impossible in the space at our disposal.

Since the publication of the "Origin of Species" several new doctrines in connection with the evolution of animal life have been propounded. Among these, one of the most important, and one which has probably played a very considerable part in nature, is that of parallelism in development: that is to say, the independent development of similar structures in different groups of animals living under similar circumstances, or in course of adaptation to similar conditions of life. Mimicry, too, is another important factor in nature, the discovery and recognition of which has taken place during the Queen's reign. The cutting of thin sections of animal and vegetable tissues, and their examination under the microscope, and the wonderful results that have been obtained thereby, are also a development of the reign, as is likewise microscopy in general. Bacteria and microbes, again, are low types of life whose investigation forms one of the greatest achievements of the latter part of the era, and the incalculable benefits which have already been conferred on suffering humanity by this line of study, are well known to our readers.

Systematic zoology and botany have passed through several stages during the period under review. As already said, at the commencement of the reign the former was labouring under the thrall of the circular hallucination, from which, however, it at length cast itself free. Since that time a steady progress has, on the whole, been made in most branches, as anyone may satisfy himself who contrasts the Linnean system (which was chiefly in vogue in 1836) with that to be found in any of the better class of modern text-books. And here it may be mentioned how vastly superior are these to their predecessors of half a century ago. Whether the progress has been equally satisfactory on the species question may well be doubted. Even early in the reign gibes and taunts were freely levelled at the "species monger," and it was thought by many that the publication of the "Origin of Species" would be the death-knell of the abstraction from which it took its name. For a time, indeed, there was a lull, and naturalists seemed inclined to take a broader and more philosophic estimate of the amount of differences which ought to be regarded as of specific importance. But of late years, and especially in America, species-making has once more taken a new lease of life, and every little more or less constant difference is now regarded as of specific or "sub-specific" value. Indeed, we have even heard it whispered that a "species" of snail has been restricted to the individuals inhabiting a particular tree-trunk. As in stamps, refinement in making distinctions is almost an inseparable sequence of ardent collecting; but it is permissible to doubt whether the hair-splitting in this respect, characteristic of the present decade, will eventually be included in the biological progress of the Victorian era.

SIXTY YEARS OF GEOLOGICAL RESEARCH.

By Grenville A. J. Cole, M.R.I.A., F.G.S.,
Professor of Geology in the Royal College of Science for Ireland.

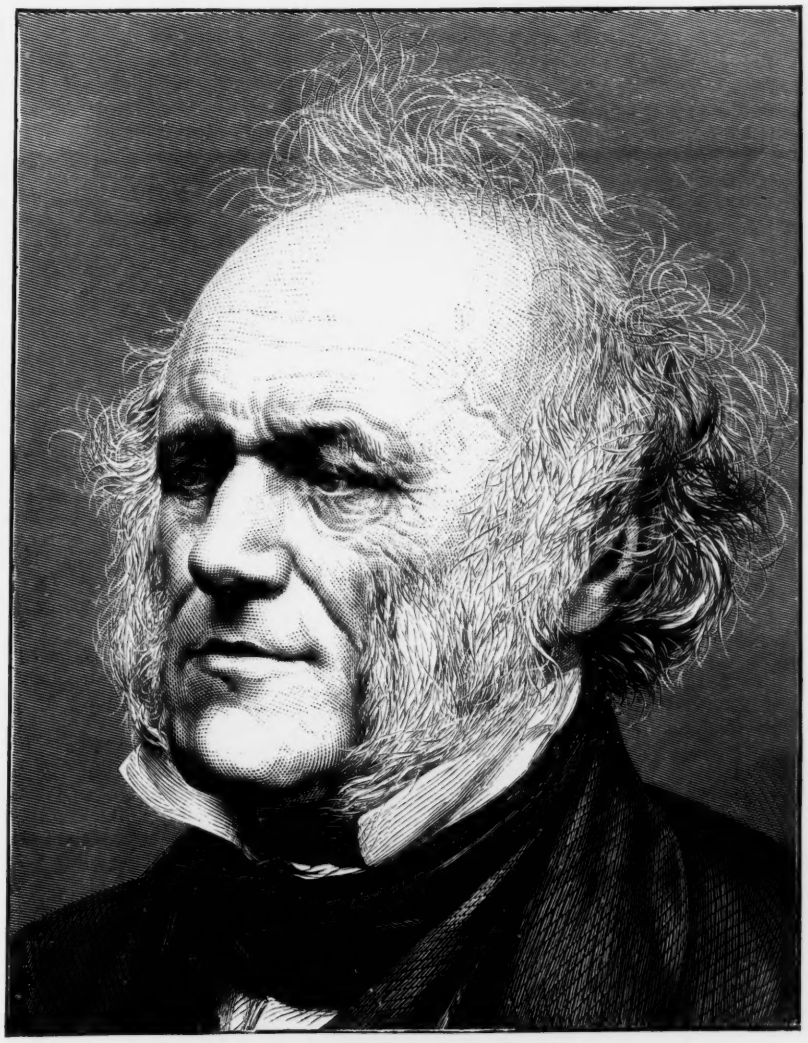
As is the case with all other sciences, the progress of geology has become more rapid, and its results have become more appreciated, in proportion to the spread of education among the peoples as a whole. Even in the old days of book-learning, pupils were at least trained to read books, and hence the discoveries of scientific men became in due time accessible to the many. Gradually it was seen that in the observation of the world around us lay the only safe clue to the history of that world in long-past ages; and a band of workers arose about the beginning of this century, prepared to treat geology as a branch of natural history, rather than as a ground for dogmatic contention and for the exploitation of theories of cosmogony.

Already, in 1807, the foundation of the Geological Society of London had brought together serious observers, and had provided a meeting-ground for those interested in the mineral or the palæontological aspects of the earth. The Geological Society of Dublin commenced its publications in 1832, that of Liverpool in 1859, and that of Glasgow in 1864; while the well-known Geologists' Association, founded in 1858, has kept hundreds in constant touch with the field-work which is the foundation of geological discovery. Thanks to the steady growth of this organization, and of the "field clubs," whose best meetings are held in the open air, geology has assumed its place at the present time as one of the most attractive sciences; and its human aspect, the insight that it gives us into the long chains of life-forms which preceded the appearance of man upon the globe, affords it, in our evolutionary days, increased importance and vitality.

The general spread of some knowledge of chemistry and physics in our schools and institutes—I write, at least, of England and of Scotland—promises that the new observers in geology will receive a more rigid training than was customary sixty years ago. In 1830 Lyell published the first volume of his famous "Principles of Geology"; and he still found arrayed against him those who preferred rapid speculation to steady observation, and the reporting of "curiosities of travel" rather than the recording of connected details. Though Lyell himself cannot (mainly on account of his defective eyesight) be classed among the great geological discoverers, yet his methods of work, his continual adaptation of the known processes of the present to the explanation of past phenomena, make him rank among the foremost teachers of the age. His caution, his very respect for the recurring cycles of James Hutton (1795), who had founded the "uniformitarian" school, made him at first sceptical as to the reality of organic evolution; but his acceptance of the views of Darwin and Wallace, very shortly after the publication of the "Origin of Species," gave a great and further stimulus to geology. Geology has since gone hand in hand with zoology in seeking to unravel the past history of the earth; and the catastrophic school, of which even Cuvier was a supporter, has reserved its epochs of deluge and explosion for periods before life existed on the globe.

With the acceptance of rational views as to the origin of the rocks which we see around us, the systematic study of the organic remains found in them became a matter of more serious interest. The foundations of historical geology had been laid by William Smith, the land surveyor and engineer, between 1790 and 1815; and Lyell's classification of the stratified rocks that were formed nearest to

our own times was only an advanced and special study on Smith's principles. Lyell established the well-known terms, Pliocene, Miocene, and Eocene, and showed what immense changes had gone on in the earth's surface even during these more recent periods. His demands on time were naturally repugnant to those who still held that the earth and all that therein is had existed for only some six thousand years; and physicists, even in later times, have stoutly opposed the geologists in their views of the extreme antiquity of life upon the globe. In the last few years, however—as Mr. Poulton has very clearly set forth in his address to the zoological section of the British Association in 1896—physical experiment has shown that the earth's crust would have reached its present temperature, on the surface of a cooling globe, in a time vastly longer than the physicists were formerly able to concede; and, consequently, geological time, though of course not limitless, may be restored to us in something like the proportions insisted on by Lyell.



SIR CHARLES LYELL, F.R.S. 1797-1875.

It is thus much more easy to conceive the successive evolution of the various life-zones that mark out the strata one from another. In 1859, Charles Darwin's "Origin of Species" afforded satisfactory reasons for regarding fossil organisms as a continuous series, the forms of one geological epoch having descended from those of a previous one; and fossils, instead of being treated as more or less imperfect experiments in creation, became the essential alphabet whereby we may trace out the progress of life upon our planet. It was only to be expected that at first many rash genealogies should be put forward, and that many supposed "connecting links" should have later to be shorn away. Even at the present time, the methods of William Smith, involving patient observation as to the relations of the beds themselves, form the only safe basis in deciding the succession of life-forms.

The Palæontographical Society undertook in 1847 the description and delineation of all British fossil species; and the magnificent series of quarto volumes issued up to the present time more than rivals the ambitious publications of the opening years of the century. Owen, who seemed a lineal successor of Cuvier, brought together into the collections of the British Museum a series of fossil vertebrates from all lands; and many of Huxley's laurels were gathered while investigating similar remains. The discovery of the relationships in structure between the skeletons of many of the cumbrous reptiles of the Mesozoic era and the light-limbed birds that seem to have arisen side by side with them, is one of the most striking results of these studies in comparative anatomy. While Mantell, Owen, Hulke, Seeley, and other workers have put before us the variety and richness of British reptilian remains, Marsh and Cope have attacked the American fossil vertebrates, and have restored a long series of Dinosaurs, from the Trias to the highest beds of the Cretaceous, which have given us altogether new conceptions of the age of giant reptiles. At the same time, the Permian and Triassic reptiles of Texas and South Africa have been shown to embody hints of the incoming of the mammals, the group of the "Theromorpha" being far less specialized along the reptilian line than are the reptiles of the present day. Owen's *Tritylodon*, from the Karoo beds of South Africa, remains our best-preserved and oldest mammalian skull; and the recent investigation of the milk-teeth of *Ornithorhynchus* has shown relationships between the earliest known mammals and the lowest existing order, the monotremes.

The "doctrine of descent," so strongly supported and vindicated by Darwin's treatise of 1859, has found the fullest confirmation in these and other facts of palæontology. The splendid series of remains of fossil horses known to us, illustrating the successive changes in dentition and in limb bones, and notably in the digits of the foot, has furnished an example that is dealt with now in every text-book. Cope has even argued for the independent origin of the horse, as a species, in America and in Europe, by similar selective influences acting on slightly dissimilar original stocks.

It must never be forgotten that Darwin himself stands in the first rank of geological observers, whether among raised beaches, or ancient lava-flows, or the coral isles of the Pacific. His diary of his share in the voyage of H.M.S. *Beagle* appeared as Volume III. of the joint report in 1839; but his special geological researches were published in 1842 (coral reefs), 1844 (on volcanic islands), and 1846 (on South America).

In this last-named year, the newly-formed Geological Survey of Great Britain issued its first volume of memoirs; the Ordnance Survey of Ireland had published Portlock's "Report on the Geology of Londonderry," etc., three years earlier. De la Beche, Ramsay, and Sir Archibald Geikie—the last-named being equally known as a man of letters—have successively directed the British Survey. Similar surveys were undertaken by most of the European states; and we owe the fine series of geological maps of the British Isles, the 1 : 80,000 survey of France, the intricate results set down in the Swiss sheets, and such admirable travelling companions as Von Hauer's map of the Austrian Empire, entirely to the labours of geologists during the last sixty years. Geological mapping is no longer a mere record of the rocks or minerals found at various points on the earth's surface: the relative ages of the strata can now be ascertained by their fossil contents; and William Smith's original sketch-map of England and Wales, published in 1815, and coloured upon this basis, has, by our time, borne abundant fruit.

We cannot pass over the striking work of the Geological Survey of India, carried on under difficulties little experienced in Europe; or the great series of volumes, a monument of public liberality, devoted to geology by the Survey of the United States. Japan and Mexico, among other countries, now furnish their full contribution to the store of geological research.

Our knowledge of structural geology has progressed with the spread of these accurate surveys, and private workers have occasionally shown how much may be done by patient investigation of a critical district, if aided by that power of comparison and generalization which converts the work of a recorder into that of a scientific master. Prof. Lapworth has thus unravelled the complex region of North-West Sutherland, and has shown us, since 1883, how we have in our highlands the basal sections of truly Alpine mountain chains. Heim in Eastern Switzerland, Baltzer and others in the Central Alps, Bertrand in the Juras, Lory in Savoy and in Dauphiné, have revealed the amount of intermingling and overfolding that has gone on in these regions since Oligocene times. The relations of the central granitic and gneissic cores of mountain chains to the strata upon their flanks becomes one of the most interesting questions raised; and it appears that, far from being the oldest masses, thrust up from below, these cores often represent re-melted material, which flowed into its present position during the actual period of mountain building. Similarly, Dr. Lawson has shown in Canada that the "Laurentian" gneiss is intrusive in the Huronian series, and is thus, in part at any rate, by no means the fundamental mass that it was once believed to represent.

Section of Olivine-basalt from Isle of Mull, as seen under microscope, × 25. *a*, Augite; *p*, Plagioclastic Felspar; *ol*, Olivine.

The publication, between 1883 and 1888, of *Das Antlitz der Erde*, by Dr. Suess, of Vienna, has exercised a most important influence on students of physical geology. This applies particularly to the relations between the levels of land and water in the past, and between areas of elevation and depression on the earth's surface. The action of old rock-masses in determining the lines of later earth movement has here been emphasized effectively.

Probably no physical problem has been attacked by geologists more keenly than that of the "Great Ice Age." Since Agassiz, Ramsay, and others pointed out, about 1850, how large a part of the northern hemisphere must have been subject to Arctic conditions of snow and ice, and that these conditions must have prevailed in quite recent geological times, theory after theory has been put forward to account for the widespread phenomena. Prof. James Geikie published his "Great Ice Age" in 1874—a work now in its third edition—and may be regarded as the strongest champion of the land-ice theory. Gigantic glaciers, extending even from the Pole, have been invoked by some, while others prefer a combination of land-ice from local centres, with floating ice bringing boulders from a distance. The cold epoch being a certainty, Dr. Croll (a review of whose life appeared in Knowledge for April, 1897) set himself to account for it on astronomical grounds; and his elaborate theory, promulgated in "Climate and Time," in 1875, held sway over the majority of geologists. Quite recently, however, Mr. E. P. Culverwell has reinvestigated the problem on a more modern basis, and regards the astronomical theory as entirely insufficient; so we may be thrown back on what were to Croll, after all, important considerations—the effect of changes in the distribution of snowfields, land, and sea, particularly by causing deviations in currents of warm air and water.

While geology began its career as a close ally of mineralogy, the excitement of palæontological discovery for a long time caused the rocks themselves to be little studied. The microscopic observations of Cordier on the constitution of lavas, carried out in 1815, bore little fruit until 1856 and 1858, when Dr. Sorby, of Sheffield, drew attention to the value of the microscope in determining the characters and mode of origin of rocks. Delesse in France had been a faithful student of polished surfaces; but Sorby now introduced the general use of sections, or of powdered materials embedded in Canada balsam. The study of minerals *in situ* by this method became a favourite one in Germany and France, and we owe some of the most important determinative tests to Fouqué, Lévy, Rosenbusch, and Groth, to mention no other names. The establishment of the first geological laboratory by Professor Judd in 1877, whereby the teachers trained under the Department of Science and Art, as well as the students of the Royal School of Mines, received practical courses of instruction, probably did more than any other influence to promote the study of rocks in the British Isles and in our colonies. There is little fear now, moreover, of British students becoming adepts in the use of microscopic sections, and forgetful of the true relations

of rock-masses in the field. The position of geology as an educational subject rests largely upon its outdoor aspects; and Anglo-Saxon geologists have always preferred to base their classification of rocks upon natural relationships traceable in the field.

We have left until the last one of the most vital problems of geological research, and one that gives to geology, if we may say so, its enormous moral value. When Lyell published, in 1863, his work on "The Geological Evidences of the Antiquity of Man" he was able to take up an attitude of marked opposition to the prevalent opinions of his day. Early flint implements were, even then, only beginning to be studied, and human remains are notably prone to disintegration and decay. Still, Lyell was able to point to the upper part of a skull, discovered in the Neanderthal in 1857, and to Huxley's description of it, as indicating a type of extinct humanity far lower than that of the average of the present day. Considering the paucity of very ancient human remains, the discovery of two skeletons with skulls of the Neanderthal type at Spy, in Belgium, in 1886, gave immense probability to the idea that a race of men of low average capacity may have at one time peopled the earth; and in October, 1891, Dr. Dubois excavated, from volcanic sands near Trinil, in Java, the calvarium described by him as *Pithecanthropus erectus*. This portion of a skull, with a well-developed thigh-bone and a molar tooth, were found associated with truly extinct and also locally extinct mammalia, and are referred by Dubois to an individual actually intermediate between man and the anthropoid apes. Other discoveries in this promising area must be looked for before geologists and anthropologists are all in accord as to the significance of these remarkable remains.

Meanwhile, Dr. Fritz Noetling, of the Indian Survey, discovered artificially chipped flint implements in Pliocene beds in Burma in 1894, and has rebutted his critics, with considerable appearance of success, in a second paper in *Natural Science* in April of the present year. In the February Number of the same journal, Mr. W. J. Lewis Abbott records similar implements from the Cromer forest bed; and few geologists can remain who would deny to man an existence in pre-glacial times. What forms preceded reasoning man may still be left in darkness; but the extreme scepticism of some archæologists, and the self-satisfaction of those who have failed to follow the course of palæontological discovery, can no longer check research into this difficult and fascinating field.

In conclusion, whatever impressions have been made by gifted public teachers, we must never forget that each generalization in geology has been founded on a multitude of researches published in our scientific journals. Hidden away there, known only to the specialist, lie the foundation stones of the science. In the multiplication of scientific observers, in their frequent self-sacrifice, in the high dignity of their aims, we may see the most stimulating outcome of the progress of these sixty years.

Notices of Books.

The Natural History of the Marketable Marine Fishes of the British Islands. By J. T. Cunningham, M.A. With a Preface by Prof. E. Ray Lankester. Pp. 375. Illustrated. (Macmillan.) 7s. 6d. The Marine Biological Association has accomplished much excellent work since it was founded in 1884; but the preparation of this volume under its auspices is more likely to lead to a wide knowledge of sea fishes and sea fisheries, and thus advance its objects, than anything it has done. The author was for some years naturalist to the Association, at the laboratory on Citadel Hill, Plymouth. His knowledge of the structure, habits, and breeding of marine food-fishes is intimate and extensive, and the present volume shows that he possesses the ability—rare among specialists in science—of being able to impart that knowledge in words which can be comprehended without a special vocabulary. The work is divided into two parts, the first dealing with the history of modern investigations in marine biology; the characteristics and distribution of valuable marine fishes; the generation and development of fishes; growth, migration, food, and habits; and practical methods of increasing the supply of fish: while the second part contains the histories of particular families and fishes. It will be gathered from this outline that all who are interested in the "harvest of the sea"—either as naturalists or as fishermen—will find the volume valuable. We will go further than this, and say that Mr. Cunningham's work is indispensable to all who desire to improve, and preserve by intelligent action, our fishing industry. In the preface, Prof. Ray Lankester points out that the book will not only be a help to trained investigators, but he also expresses the hope "that it may help those who are responsible for giving or withholding public funds to the thorough investigation of marine fisheries, in forming a judgment as to the nature of the problems which have to be solved." With this wish we cordially agree. While the United States Fish Commission receives seventy thousand pounds a year from the Government, our Marine Biological Association has only an annual budget of about two thousand pounds, and this is quite insufficient to place the laboratory at Plymouth upon a properly efficient footing, while the extension of fishery investigations to other parts of the coast is out of the question. Mr. Cunningham's book will certainly show the public the need of a more generous recognition of the aid which the Association is able to give to the sea fisheries industry; and it will also interest, as well as instruct, all who read it. The illustrations are of the clearest description, and are plentifully distributed through the volume.

Astronomical Observations and Researches made at Dunsink, the Observatory of Trinity College, Dublin. This volume is the result of a project in 1885 of Sir R. S. Ball, then Director of Dunsink Observatory, in the case of those stars whose proper motion is both large and already well determined, to detect any possible variation in its amount, and where it may be due to errors in previous catalogues to remove any ambiguity. To keep the work within reasonable compass, the investigation was restricted to those stars whose annual proper motion exceeds 0·2″. In addition to these a number of stars not characterized by exceptional proper motion were observed for special reasons. These included stars required by Dr. Gill for solar parallactic researches, and by Dr. Downing for use in the *Nautical Almanack*. In the course of these observations a new determination was made of the latitude of the meridian circle. In the winter of 1873-74 Dr. Brünnow had found for this the values 53° 23′ 14·08″ and 53° 23′ 13·14″, when the clamp of the telescope was in the east or west direction respectively, the instrument having been reversed in the interval. With the same instrument and the same method of observing, Dr. A. A. Rambart found the latitude values for the east and west positions respectively to be 53° 23′ 13·07″ and 53° 23′ 13·27″. The fact that the differences in these two sets of values are of opposite signs seems to negative the idea that they are largely due to division errors at the nadir reading. The adopted value of the latitude is 53° 23′ 13·00″. In all twelve hundred and seventeen observations of two hundred and thirty-six stars were obtained in right ascension, from which the

probable error of a single determination in this co-ordinate was found to be $\pm 0{\cdot}037$s.; and twelve hundred and eleven observations of two hundred and thirty-five stars in declinations varying from $+65°$ to $-21°$, with a probable error of $\pm 0{\cdot}505''$. Incidentally, in the latitude determination, the probable error of a single observation of declination was found to be $\pm 0{\cdot}57''$.

Charles Darwin and the Theory of Natural Selection. By E. B. Poulton, M.A., F.R.S., etc. (Cassell.) 3s. 6d. This is one of the excellent short biographies now being published in the "Century Science Series." Prof. Poulton's task in dealing with such a great life in so small a space has been admittedly a difficult one, and he is to be greatly complimented for the clever way in which he has told a great deal in a few words. We feel sure that this little book will be of the greatest service to the student who reads it. If he has studied Darwin's works he will find here a history, summary, and short discussion of each of those works, and will obtain besides an insight into the life of the man himself. If, on the other hand, he has not read Darwin's works, this book will assuredly make him long to read them. Of course Prof. Poulton has largely drawn upon the "Life and Letters," but he has selected his information with great skill, and his narrative runs smoothly and is always intelligible. The history of the theory of natural selection, and the connection of Darwin and Wallace, is indeed well told. Besides being a sort of epitome of the "Life and Letters," the book contains some valuable correspondence between Darwin and Prof. Meldola which has not before been published. It may be mentioned that Prof. Poulton wisely refrains from expressing any opinion of his own on the theories of Darwin. The book should therefore interest everyone, whatever views he may hold, as a history of our greatest naturalist.

Pioneers of Evolution from Thales to Huxley. By Edward Clodd. (Grant Richards.) Portraits. 5s. At the present time, when so much interest is centred in the many-sided problem, evolution, a work tracing the origin and development of thought on whence we came, whither we are going, and the constitution of the cosmos should be welcome. Not that there is a dearth of such works, but rather because an accession of light on the dark pathway may be hoped for by the independent efforts of individual minds presenting facts in new aspects. Mr. Clodd is, of course, well known, and he has stamped his individuality on this contribution to literature. Indeed, he has so far introduced his own personality as to thoroughly spoil the otherwise most enthralling story, the general result being rather a compilation from the pioneers themselves, to emphasize Edward Clodd's own ideas, than an account of the views of philosophers from Thales to Huxley. This disagreeable element reaches its culminating point where Mr. Clodd tells the story of Dr. A. R. Wallace's declining to accept Darwin's hypotheses in their entirety. Wallace would not allow that natural selection explains the origin of man's spiritual and intellectual nature. Mr. Clodd says (p. 138), "Minds of this type must be built in watertight compartments. They show how, even in the higher culture, the force of a dominant idea may suspend or narcotize the reason and judgment." And (p. 144) he continues: "That which, under wholesome restraint, is the initiative and incentive of inquiry, of enterprise, and of noble ideals; unrestricted, leads the dreamer and the enthusiast into engulfing quicksands of illusions and delusions." Thus at one fell stroke, in his own way, Mr. Clodd brings Dr. Wallace down from the sublime to the ridiculous.

Is Natural Selection the Creator of Species? By Duncan Graham. (Digby, Long & Co.) 6s. In these pages it is maintained that the present condition of the earth and its inhabitants cannot be explained by the action of physical forces alone. The arguments brought forward in support of this statement are worthy of careful consideration, but the hasty and immature deductions in various places and on many controverted points are not at all convincing. Apparently the author is in some measure conscious of all this, for he says in the preface: "I hope any who read my book will pass over the defects of the manner, and find the matter worth a perusal." On such questions as heredity, variation, reversion, male and female, the moral sense and mental powers, our author asks many questions which we, at any rate, would not undertake to answer.

The Survival of the Unlike. By L. H. Bailey. (Macmillan.) Illustrated. 8s. 6d. A very fair notion of the trend of this work may be gathered from the author's own words. He says: "To me, the chief demonstrative reason for belief in evolution is the fact that plants and animals can be and are modified profoundly by the care of man. In fact, I should be convinced that the organic creation is an evolution if I had no other proof than this." And so Mr. Bailey goes on to the bitter end with the same cocksureness, leaving us no alternative but to accept implicitly all he says.

Healthy Dwellings. By Sir Douglas Galton. (Clarendon Press, Oxford. 1896.) 10s. 6d. As a handbook of hygiene, this well-known work of Sir Douglas Galton deserves a front place. The author has now for so many years been before the public as an exponent of modern methods of sanitation, that his information on such subjects is well worthy of acceptance by the student and younger generation of experts, who are prone to draw hasty conclusions from the immediate data before them. So many professional men have now to consider the fundamental laws of health, that a book like the one before us should have a wide and general circle of readers. The sixteen years which have elapsed since the first edition have brought enormous changes, more especially in our knowledge of the causation of disease and in bacteriological problems, and one would have liked many of the chapters further developed in these directions. Thus, for example, on pages 38 and 39, we must take exception to the modern accuracy of the sentence: "Phthisis and other diseases may result from breathing air rendered impure by the putrefying organic matter thrown off from the human body in the process of breathing and transpiring." In discussing the purity of water, the author has generalized too freely. Most chemists, for example, would object to his dictum that "if the residue blackens in burning, it indicates *animal* organic matter." As a general handbook of reference, it should be of value to many of our readers.

First Lessons in the Art of Wild Fowling. By Abel Chapman, F.Z.S. (Horace Cox.) Illustrated. 10s. 6d. Mr. Chapman is well known as an accomplished wild-fowler, and in the present volume he gives some valuable hints on shore shooting and punt gunning. A great number of books have been written on the subject, and perhaps there is little new to teach. Mr. Chapman attacks his subject more from the naturalist's point of view than previous writers, and for this reason, as well as for the sound advice on technical details, we would recommend the book. We are glad that the author declaims against the unsportsmanlike procedure of firing at birds at enormous ranges with guns loaded with ball. This practice cannot be too severely condemned. Besides having the effect of frightening and wounding the birds, and thus spoiling legitimate sport, it reduces punt gunning, which, when

carried out in a proper way, is one of the most difficult and sportsmanlike pursuits, to mere butchery. The art of wild fowling cannot be learnt from a book—experience bought by many a bitter failure must be the teacher—but it is very valuable to be able to supplement our own experience by a study of so accomplished a wild fowler's methods. Besides the hints on the way to obtain the birds, there are many valuable observations on their haunts and habits, and many interesting reminiscences of days and nights spent by the author in his favourite pursuit. The illustrations are for the most part excellent, and prove that the author, notwithstanding his modesty, is no mean artist.

SHORT NOTICES.

Who's Who, 1897. Edited by Douglas Sladen. (London: Adam & Charles Black.) 3s. 6d. This is the first number of the new series of an old friend, introduced with due formality by Mr. Sladen. It is, of course, inevitable that such a work should exhibit a considerable selection of more or less obscure items, but a cursory glance through its pages reveals many improvements in its method as well as in its manner. Several bulls are perpetrated, as is proper, in regard to Ireland, where we find that Mr. Justice Ross is made to combine the labours of a Member of Parliament with the recreations of the Irish Judicial Bench, a quite impossible combination; Prof. McNeil has been converted into a Parnellite member; while the County Monaghan (north division) is credited with the wrong member altogether. Among the omissions we may mention the President of the Institute of Bankers, the Chairman of the London County Council, the President of the Anthropological Institute, Mr. Walter Sickert, and the President of the British Astronomical Association. Yet the book is withal a valuable companion, especially to those whose unhappy fate it is to wrestle with the columns of the daily press.

The Literary Year-Book, 1897. Edited by F. G. Aflalo. (London: George Allen.) Illustrated. This is an altogether disappointing book, having regard to the scope and interest of its subject, and we can only hope that its imperfections may at least have the utility of pointing the way to something better next year. That no year-book of literature has presented itself for our guidance before should urge its editor to make his book worthy the occasion.

European Architecture: a Historical Study. By Russell Sturgis, A.M., Ph.D., F.A.I.A. (Macmillan.) Illustrated. 18s. A history of architecture in Europe, ranging from prehistoric times to the close of the last century, is an undertaking of vast magnitude; but such a survey reveals to the mental vision a spectacle of surpassing beauty—of noble endeavour. Such a book is this. By the aid of a vigorous and scholarly pen, Mr. Russell Sturgis conducts us through the varied changes and developments of his subject, so that his volume may be read with pleasure, and studied with profit, from the first page to the last. The book is furnished with a descriptive glossary, together with an index, and is beautifully illustrated with some two hundred and fifty views, many of them taken from the leading works on the subject. There are also ten plates inserted, mainly consisting of views of famous cathedrals, such as Florence, Antwerp, Salisbury, etc.

Ireland. By R. Barry O'Brien. The Children's Study. (London: T. Fisher Unwin.) With Map. 2s. 6d. This admirable narrative of Ireland's eventful story may be commended to children of a larger growth than the young people it is intended to interest. Mr. Barry O'Brien has skilfully woven the leading episodes in his country's history around some central figure in the ever-changing scene, and the thrilling stories of Shane O'Neil, of Art Macmurrough, and Owen Roe O'Neil, in earlier times, combined with the eloquence and pathos of later years, should fire the youthful student to a more extended acquaintance with the men and the movements which have made Irish history. In this pursuit he will not find a better guide than Mr. Barry O'Brien.

What to do in Cases of Poisoning. Murrell. Eighth Edition. (H. K. Lewis, Gower Street, W.C. 1897.) This handy book of emergency, not only to medical men, but also in every household, has proved its utility by reaching the eighth edition. In country houses and in the colonies it should form one of the books in the medicine chest, and then, whether a doctor is in call or not, cannot fail to be helpful in any sudden cases of poisoning.

We have received three special parts of *Poems for the Schoolroom and the Scholar* (*Review of Reviews* Office; each sixty-four pages and wrapper, 1d.), and we cannot too highly commend these wonderful little books to the use of teachers as well as scholars in elementary schools.

Elements of General Philosophy. By George Croom Robertson, late Grote Professor, University College London. Edited by Mrs. C. A. F. Rhys Davids, M.A. (London: John Murray.) 3s. 6d. This is one of the invaluable University Extension Manuals issued by Mr. Murray, and forms a companion volume to Robertson's "Elements of Psychology." In editing these two volumes of lectures for the use of students, Mrs. Rhys Davids has rendered available a most comprehensive as well as a very suggestive survey of the whole field of thought.

Now that the touring season is approaching, it is fitting that due precaution be taken to secure the fullest advantage of available opportunities. The finely illustrated catalogue just received by us from Messrs. Watson & Sons is a timely reminder that amateur photography is, perhaps, the most pleasing diversion when visiting interesting localities, because the perpetuation of the scenery in one's own practical work is generally associated with many incidents which, so to speak, invest the past with a new lease of life. The "Acme" camera seems a really good, light, portable, and compact instrument, the means for focussing and general adjustments being patterns of ingenuity in mechanical contrivances. We note also the "motorgraph," which affords the advantages of being able to record by photography street scenes, in which the animate subjects move exactly as in real life.

BOOKS RECEIVED.

First Principles of Natural Philosophy. By A. E. Dolbear, Ph.D. (Ginn & Co.) Illustrated. 4s. 6d.

War, Famine, and Our Food Supply. By R. B. Marston. (Sampson Low, Marston, & Co.) 2s.

Inorganic Chemistry. By G. H. Bailey, Ph.D., and W. Briggs, M.A. (Clive.) Illustrated. 2s.

Smithsonian Institution—Report of the Board of Regents, 1894. (Government Printing Office, Washington.)

The Literary Year-Book, 1897. Edited by F. G. Aflalo. Portraits. (London: George Allen.)

Who's Who, 1897. Edited by Douglas Sladen. 3s. 6d. (London: Adam & Charles Black.)

Early Essays. By John Stuart Mill. 3s. 6d. (London: George Bell & Sons.)

First Principles of Mechanical and Engineering Drawing. By H. Holt-Butterfill, M.E. (Chapman & Hall.) Illustrated. 7s. 6d.

Results of Meteorological and Magnetic Observations, Stonyhurst College Observatory, 1896. (Parkinson & Blacow, Clitheroe.)

Picture Lessons in Natural History. Three wall charts on one roller. (Bacon.)

Geology of North-East Durham. By D. Woolacott, B.Sc. (Hills & Co., Sunderland.) Illustrated. 1s. 6d.

Ancient Volcanoes of Great Britain. By Sir Archibald Geikie. (Macmillan.) Illustrated. Two volumes. 36s. net.

Practical Plane and Solid Geometry. By Thomas Jay Evans and W. W. F. Pullen. (Chapman & Hall.) Illustrated. 9s.

The Elements of Electro-Chemistry. By Dr. Robert Lüpke. Translated by M. M. Pattison Muir, M.A. (Grevel & Co.) Illustrated. 7s. 6d.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

STAR SYSTEMS.

To the Editors of KNOWLEDGE.

SIRS,—In reply to Mr. Backhouse I take the following proper motions from Herz and Strobl's revision of the Catalogue of Auwers:—

Star.	Motion in R.A.	Motion in Decl.	Velocity (Vogel).
β Ursæ Majoris ...	+0·0038 ...	+0·039 ...	−18·2
γ Ursæ Majoris ...	+0·0110 ...	+0·003 ...	−16·5
δ Ursæ Majoris ...	+0·0146 ...	−0·003 ...	Not given.
ε Ursæ Majoris ...	+0·0131 ...	−0·035 ...	−18·8
ζ Ursæ Majoris ...	+0·0143 ...	−0·027 ...	−19·4

The proper motions above given agree very closely with those in the Pulkova Catalogue, and therefore may be taken to represent the results of observation up to the present. I think the agreement is not close enough to afford any satisfactory evidence of physical connection, and the motions are too small to be determined with accuracy. When I spoke of exceptional motions I was referring to quantity. There is sufficient variety in the motions of the stars in almost every region of the sky to prevent the directions of the motion of particular stars from presenting anything

very exceptional. The motions of the stars which I cited in my former letter are much in excess of the usual amount. Those of the above five stars are not so.

The best agreement is perhaps that determined by Vogel for the velocity in the line of sight. It does not, however, include δ; and for η Ursæ Majoris (which admittedly does not belong to the system) he determined −16·3. The motion of η is R.A. −0·0104, Decl. −0·019.

I am not aware of the proper motion of Alcor, but I would expect to find that it agreed closely with that of ζ Ursæ Majoris, and that a physical connection existed between the pair. But this would afford no ground for including β, γ, δ, and ε in the same system.

It is favourable to the theory of a physical connection between these five stars that they all present the same kind of spectrum, A. But here, again, η presents the spectrum A also; α, on the other hand, has the spectrum K, and less than half the velocity in the line of sight of the other six.

W. H. S. Monck.

THE CHEMISTRY OF THE STARS.

To the Editors of Knowledge.

Sirs,—In your last issue Mr. Maunder mentions some facts which he believes to be adverse to the hypothesis of the uniform chemical constitution of the heavenly bodies, but to my mind, at least, they are not inconsistent with such a view. The idea that difference of temperature is the fundamental cause of differences in stellar spectra does not necessarily involve the supposition that each star must pass through stages represented by every one of the "peculiar spectra" which has been observed. Pickering, for example, has shown that some of these exceptional spectra are composite, the components representing stars of different ages, and such a compound spectrum would not be put on by single stars. Other special variations of spectrum, due to the interaction between two bodies in close proximity, are not inconceivable, and, in fact, are probably revealed to us in many variable stars.

Again, there appears to be no sufficient reason why the peculiar distribution of the bright-line stars should not indicate a ring of stars of equal temperature. This is at least as easy to conceive as a ring of stars of unusual chemical composition.

Coming now to the objection that in the Milky Way large and small stars of apparently the same type are associated, it is necessary to state that a great variety of spectra has hitherto been very commonly included in the same spectral type. For instance, all stars with well-developed hydrogen lines are classed together by those who still hold to Secchi's classification, although individual spectra may be very different. Not having given special attention to the stars of the Milky Way, I am unable to say whether the supposed identity of the so-called "first type stars" of different magnitudes composing it is really established, but I do not think the published accounts of the spectra are sufficiently detailed to permit a trustworthy conclusion to be drawn. But there is another point. The period required to produce spectral modifications great enough for detection must be of very considerable duration, so that stars of unequal masses in the same part of space may appear to be at practically the same spectral phase at a given time, although the smaller may in reality be further advanced. The apparent identity of bright and faint stars of the Pleiades group may similarly rest upon inconclusive data, but, as Lockyer has pointed out, the fact of these stars being involved in nebulæ offers another explanation.

With regard to the last point which Mr. Maunder suggests for my consideration, I would only say that to deny the similarity of chemical composition of nebulæ and stars is to deny the possibility of nebulæ and stars having any connection at all.

Making due allowance for our fragmentary knowledge, I still think that the spectroscopic phenomena presented to us by the heavenly bodies do not clash with the view that their chemical composition is uniform.

A. Fowler.

[Mr. Fowler has evidently missed the point of the last paragraph of my note on page 99. If some vast nebula crystallizes out into a number of stars, then, unless the nebula be *strictly homogeneous throughout*, the discrete stars formed from it must vary in their composition, which must in each case correspond to that of the particular region of the nebula from which each one was severally formed. Mr. Fowler's penultimate paragraph does not appear to me to have any relation to my suggestion. It is one thing to admit that the chemical composition of nebulæ is on the average similar to the chemical composition of stars; indeed, the matter is beyond contention. It is a wholly different thing to assert that all nebulæ are of the same proportionate composition, and are all strictly homogeneous throughout.—E. Walter Maunder.]

ON THE VEGETATION AND SOME OF THE VEGETABLE PRODUCTIONS OF AUSTRAL-ASIA.—II.

By W. Botting Hemsley, F.R.S., F.L.S.

THE popular impression respecting the Australian flora is that it contains comparatively few plants yielding products of economic value, and this is a correct impression so far as edible fruits and vegetables are concerned; but it should be remembered that this is true of most countries. Fruits and vegetables that come to our tables are the result of long generations of cultivation. Take the crab, carrot, parsnip, celery, or almost any of our fruits or vegetables in a wild state, and we should get very little satisfaction out of them. This, however, is a little digression. Australia is by no means poor in vegetable products, and other countries have been greatly enriched by importing and cultivating some of them. This is notably the case with regard to the gum trees. I have already mentioned that the expeditions of Dampier and Cook revealed the existence of gum trees in both Western and Eastern Australia, but neither expedition entered the country sufficiently far to discover the real forests. Everybody has heard or read of the gold mines of Western Australia—of Coolgardie and that region—but few persons in this country have seen or heard of the recent report of the Conservator of the forests of that part of the world. A glance at the illustrations in that report would astonish anyone acquainted only with the forests of Europe, for they equal, if not in some respects surpass, the coniferous forests of North America. Mr. J. Ednie-Brown, the author of the report in question, has been successively Government Conservator of Forests in South Australia, New South Wales, and Western Australia, and therefore writes with great authority on his subject. He states that there are forty-seven million acres of land in Australia upon which useful marketable timber is growing, and that there are six hundred different species or kinds of timber trees in Australia! In his enthusiasm, Mr. Ednie-Brown has included a large number of trees that do not yield timber of any appreciable commercial value; but even if we reduce the total by one-half, what a contrast as compared with the richest forest districts of the northern

temperate regions, especially Europe! With all this wealth in variety, however, almost the only commercially important kinds of Australian timber are the gum trees, and only about a score of these out of the hundred and thirty-five species, or thereabouts, spread over the country.

There is so much to be said concerning these wonderful trees that one hardly knows where to begin and where to leave off; but I think the historical part deserves our attention. I have mentioned the allusions to them in Dampier's and Cook's narratives; yet it was no one connected with either of these expeditions that named and described this genus in botanical language. This was left for a foreigner to do. It was C. L. L'Héritier de Brutelle who founded the genus *Eucalyptus*, in his *Sertum Anglicum, seu Plantæ Rariores quæ in hortis juxta Londinum, imprimis in Horto Kewensi excoluntur* (1788); so we have at least the satisfaction that it was founded on a plant cultivated at Kew, and, according to the author, introduced into this country by William Anderson, surgeon, and David Nelson, gardener, who took part in Cook's third voyage around the world.

Incidentally I may mention that Nelson previously worked in Kew Gardens, and subsequently accompanied Captain Bligh on his voyage to the South Seas to introduce the breadfruit tree into the West Indies; and he was one of those turned adrift in a small boat with Captain Bligh by the mutineers of the *Bounty*. He survived the perilous and exhausting journey across the Pacific to Timor, the first land they touched, where, however, he succumbed to the privations he had undergone.

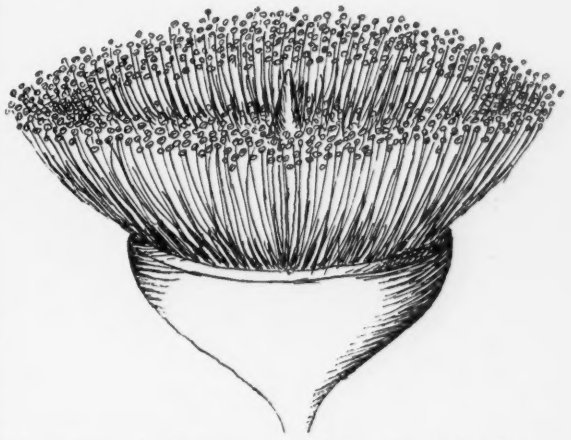
A coloured figure of a second species was published in White's "Journal of a Voyage to New South Wales," 1790.

The genus *Eucalyptus* belongs to the same family of plants as the common myrtle, though this fact is not obvious to persons unversed in botanical classification. The name is of Greek derivation, given in allusion to a peculiarity in the floral structure, which I will attempt to describe and define by means of the accompanying figures.* There are two principal modifications in the structure of flowers generally—the one in which the sepals forming the calyx, or outer covering, are combined, and the petals forming the corolla, or inner covering, are also combined, as in the primrose; the other in which the sepals and petals are free from each other and fall away separately, as in the buttercup. As already mentioned, the genus *Eucalyptus* belongs to the myrtle family, in which the petals are almost invariably free from each other and fall away separately; but in *Eucalyptus* itself there is an exceptional condition of the parts of the flower. Briefly, the sepals and petals are usually fused or consolidated into one body, which is thrown off in the form of a lid or extinguisher by the expanding stamens, and is commonly called the operculum. In some species, as in *E. Globulus*, the blue gum, there are two lids—an outer very thin membranous one, which is thrown off early, and an inner, thicker one, which in *E. Globulus* itself is not unlike a crown. The shape of the lid or operculum varies greatly in different species. The extremes are presented by *E. Globulus* and *E. Lehmanni*. In the latter it is cylindrical and an inch and a half long, and it is sometimes used as a cigarette-holder. After the lid is thrown off, the stamens, which are exceedingly numerous, spread out, as shown in the accompanying figures.

A flower of *Eucalyptus Globulus*—the two lids raised showing the incurved stamens. Slightly enlarged. Copied from Mueller.

A flower of *Eucalyptus Globulus* after the lids have been thrown off. Slightly enlarged. After Mueller.

The flowers of the gum trees, as well as the fruits or seed vessels, vary greatly in size and colour. Thus in *E. crebra* the whole flower, with outspread stamens, is hardly a quarter of an inch across, whilst in *E. macrocarpa* it is as much as three and a half inches across. In this species the filaments (threads) of the stamens are crimson and the anthers are yellow, associated with foliage of a blue green similar to the garden pea, but more intense, and in form something like the common laurel, but far thicker and denser. Excellent paintings of this and other species of *Eucalyptus* may be seen in the North Gallery at Kew.



A flower of *Eucalyptus macrocarpa*. Natural size. After Mueller.

Before entering into further particulars respecting the morphology and uses of the gum trees, I will give an account of the geographical distribution of this peculiar genus. Altogether about one hundred and thirty-seven species are known, and of these one hundred and thirty-four are confined to Australia, ranging from east to

* For the sketches illustrating these articles I am indebted to Miss Ethel Walker, of the Bedford Park School of Art. The figures in the present paper were copied from the late Sir F. von Mueller's *Eucalyptographia*; but all the rest are original.

XUM

west, and from the southern temperate parts to the extreme north, within ten degrees of the Equator. Two or three of the Australian species have been found in New Guinea, and probably more remain to be discovered. One extends to Timor, where there are two other species. One has been found in the Celebes and one in New Britain, and fourteen are recorded from Tasmania; yet not a single species is a native of either New Zealand or New Caledonia, both of which countries are situated within the parallels of latitude covered by Australia. Their dispersion in Australia is very peculiar. A few of them range across the country from east to west and north to south, whilst others are exceedingly rare and local. The greatest number of species is recorded from New South Wales, where fifty-four species have been found, but only four of them have not been found elsewhere; whereas of the forty-seven found in Western Australia, thirty-seven appear to be confined to that region, and four of the fourteen Tasmania species are peculiar to that island.

THE NEBULA ROUND η ARGÛS.

By E. WALTER MAUNDER, F.R.A.S.

THERE are some objects in the heavens which never seem to lose their interest, however often they are examined; we can turn to them whenever an opportunity for their observation occurs, and still find their beauty fresh and their marvel and mystery inexhaustible. To us Northerners the great nebula in Orion holds an easy primacy amongst objects of this class; for our more fortunate brethren in the South, its precedence is disputed by the nebula round the most mysterious of variable stars, *Eta*, in the Keel of the Ship. So, though we have already presented to the readers of KNOWLEDGE no fewer than seven illustrations of this object within the last six years, we feel sure that they will welcome an eighth, especially one that can teach us much by comparison with its predecessors.

Before referring to the photograph it is necessary to say a few words about the telescope with which it was taken, for it must be remembered that not only is there such a thing as "personal equation" for direct visual work, but when we enter the domain of photographic observation we have to recognize systematic peculiarities of more than one kind, and especially what we may term an "instrumental equation," depending on the class of instrument employed.

In this case the telescope was a very special one. So long ago as 1883, Prof. E. C. Pickering, under whose direction the present photograph was taken, had pointed out the great usefulness, for certain fields of research, of what is commonly spoken of as a portrait combination. And after having recommended in vain the adoption of a doublet objective for the work of the International Photographic Chart, Prof. Pickering, in 1888, appealed for a sum of fifty thousand dollars in order to build such an instrument, with an aperture of twenty-four inches and a focal length of eleven feet. Miss Catherine W. Bruce, so well known, not only in her own country, but on both sides of the Atlantic, as a most generous helper of astronomy, at once responded to this appeal; and in the autumn of 1889 the order for the construction of the telescope was placed with Messrs. Alvan Clark & Sons, the rough discs being furnished by Mantois. The instrument, when completed, was mounted first at the Harvard College Observatory, Cambridge, Mass.; it was then despatched, in the winter before last, by sea to the astronomical colony which Prof. E. C. Pickering has founded at Arequipa, Peru. Here Prof. Bailey took the annexed photograph on June 1st, 1896, with an exposure of four hours. Another photograph, taken five days later with an exposure of sixty-two minutes, and embracing the cluster N.G.C. 6069, has, with the photograph from which the accompanying plate has been taken, been reproduced by photogravure, and Prof. Pickering has distributed a number of the copies thus made, mostly to observatories. A third photograph, which was taken on June 11th, and which embraces the Trifid Nebula, appears in *Popular Astronomy* for April. These reproductions afford a significant testimony to the high value of the work which Prof. Pickering has been enabled, by the munificent liberality of Miss Bruce, to put in hand. And it opens a wide field of research to astronomers who may possibly possess no telescope themselves, and who may be quite unable to travel to southern latitudes, for Prof. Pickering contemplates furnishing contact prints on glass from the original negatives—a method of reproduction far more satisfactory than photogravure prints, for purposes of scientific measurement and examination—to such astronomers as will make use of them.

It will be instructive to compare together the different representations of this grand nebula that have appeared in KNOWLEDGE at various times, and of which a list is given in the following table:—

PLATES OF THE NEBULA ROUND η ARGUS.

No.	Photographer.	Appearing in KNOWLEDGE for	Instrument.	Aperture.	Focal Length.	Scale of Print. 1° =	Exposure.
				in.		in.	
1	Russell	1891, June	Portrait lens	6	32 in.	0·566	3 hours.
2	Russell	1893, March	Portrait lens	6	32 in.	1·8	8 „
3	Russell	„ „	Astrographic	13	11 ft.	6¾	8 „
4	Herschel	1893, April	Reflector	18	20 ft.	6¾	Sketch.
5	Gill	„ „	Astrographic	13	11 ft.	6¾	12·2 hours.
6	Russell	1894, June	Astrographic	13	11 ft.	2·4	5·7 „
7	Russell	„ „	Portrait lens	6	32 in.	0·65	8 „
8	Bailey	1897, May	Doublet	24	11 ft.	2·4	4 „

The value of the first photograph lies, I think, rather in the evidence it affords of the wonderful progress that has been made in astronomical photography since it was taken—*i.e.*, in less than seven years—than in its direct merit. Only little of the nebula is to be seen, a circumstance commented on by Mr. Ranyard at the time as showing that the nebula was deficient in actinic or photographic light. The small scale of the photograph prevents much detail being made out; but, on the other hand, the large field enables us to see the position and bearing of the nebula with regard to its surroundings, and the separation between the northern or "keyhole" portion of the nebula and the southern portion is seen distinctly to

NORTH.

FOLLOWING.

PRECEDING.

THE η ARGÛS REGION OF THE MILKY WAY.

From a Photograph taken by Prof. BAILEY, June 1st, 1896, at Arequipa, Peru, with the Bruce Photographic Telescope of twenty-four inches aperture, and eleven feet focus. Exposure, four hours. Scale, 2·4 in. = 1°.

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lie upon a "great lane," which may be traced far to the north-west, and which here curves round to the east before it loses itself. The extremest southern extent of the nebula abuts in similar manner upon another lane, running an undulating course from east to west. The marvellous thinning out of the stars towards the south-western corner of the plate reminds us that we are here on the edge of one of the most remarkable inlets which invade the Milky Way.

Our next photograph, the left-hand one of the pair between pages 50 and 51 of Vol. XVI., shows a wonderful advance, due partly to a more prolonged exposure—eight hours as contrasted with three—and partly, no doubt, to an improvement in the plates and in the manner of their development. The lens is the same as that employed before, but the photograph has been enlarged more than three diameters from the original negative. Several of the "dark lanes" are distinctly traceable, but now the one which seemed to separate between the northern and southern parts of the nebula appears to dive under it. The nebula itself is greatly extended, the "keyhole" or "lemniscata" has all but disappeared, drowned in nebular light, and the southern portions of the nebula extend their milky light far over regions which appeared to contain nothing but star points in No. 1.

No. 3, the right-hand photograph facing No. 2, was taken with the Astrographic telescope of thirteen inches aperture, used for the International Survey of the Heavens; the exposure, as for its companion picture, was eight hours. Here, again, we have a picture strongly contrasted with the two we have already considered. Like the second, it has been enlarged from the original negative, and is on a scale nearly four times as great as No. 2, and about twelve times as great as No. 1. The contrast between it and its companion picture is very great, and a hasty glance might lead one to give the palm of superiority to the picture on the smaller scale; it is certainly the more impressive. The moment, however, that we carefully examine the photographs, we find that No. 3 shows us many more stars than No. 2; that these stars have discs both relatively and absolutely much smaller than the corresponding stars on the other plate; and that what in No. 2 is a mere "smudge" of nebular light, is here presented to us with a refined delicacy of detail. We trace at once an association of stellar points with the intricate configurations of the nebula, but it can scarcely escape us that some of the stellar groupings are perfectly irrespective of the nebula.

On the other hand, the enlarged scale causes us to lose something. The area covered is but one-seventieth of that of No. 1 and but one-twelfth of that of No. 2, and the consequence is that the nebula and the star clusters are not thrown up into such distinctness by contrast with the darker regions surrounding them. Vast areas of nebulosities, too, that come out bright and definite in the second plate, are here entirely unrepresented, or merely suggested and hinted at, at the best. The "personality" of the two instruments is brought into striking evidence; the one revealing much more definitely the extent of the diffusion of the nebulous matter, the other far surpassing it in the amount of delicate detail it reveals, and in its suitability for yielding precise determinations of star places under the micrometer.

Our fourth plate is of an altogether different order; it is Sir John Herschel's drawing of the nebula, as made with his twenty-foot reflector. Here we are at once struck with the inferiority of even the most careful and painstaking drawings to the results obtained by photography with much smaller instruments. To begin with, great stretches of nebulosity clearly revealed to the photograph have escaped even the practised vision of Sir John Herschel. Further, the field opened to him at any single view was far more restricted than can easily be commanded by a single photographic plate. But, above all, the complexity of the object made its delineation "a work of great labour and difficulty," and occupied him for many months of the most exacting toil, until, as he himself said, he almost despaired "of ever being able to transfer to paper with even tolerable correctness its endless details."

There is yet another difficulty to which our attention is at once drawn when we compare Herschel's sketch with the photographs. One of the most striking features of the sketch is a bright zig-zag, almost exactly on the central horizontal line of the sketch, but a little to the left of the centre. In shape it is rather like a capital S that has been slightly smudged. Mr. Ranyard spoke of it as a curious trident-shaped structure; Dr. Gill compared it to a swan. In the sketch it is inferior in brilliancy only to the part of the nebula immediately surrounding the "keyhole." In the photographs which we have yet examined it is non-existent. At first sight, therefore, we have here most definite evidence of change in the nebula. But we must bear in mind that whilst we can compare the brightness of two objects, both within our sight at the same time, it is most difficult to carry such a comparison in our minds, and more difficult still to express it accurately in a sketch.

The fifth plate gives us a finer result still. Here we have the Astrographic telescope again at work, and the eight hours' exposure being now lengthened out to twelve, we have not only the sharp stellar images, the numerous stars, and the delicate detail and large scale of No. 3, but we have also an extent of nebulosity very nearly equal to that of No. 2.

The sixth and seventh plates need not detain us. Their principal value was well pointed out by Mr. Ranyard at the time, in the striking evidence which they afford of the radiation of star streams from the nebular centre.

We now come to the photograph with the Bruce telescope. The scale, it will be noted, is precisely that of the sixth plate; the exposures two hundred and forty minutes as compared with three hundred and forty-three; but the effective light-gathering power of the telescope was not far short of four times as much. Comparing it with the wonderful photograph of Dr. Gill (No. 5), with an exposure three times as great, and therefore practically not differing much in total light reception from No. 8, we find that the later plate is distinctly inferior as regards the number of stars shown, but in extent of nebulosity it has a distinct superiority, and is very strictly comparable in this respect with No. 2, to which double the exposure had been given. The ratio of aperture to focal length for No. 2 and No. 8 is practically the same. The result, therefore, of constructing a telescope of four times the linear dimensions of that employed for No. 2 has been to secure the same extent of nebulosity with half the exposure, to render it on the original negative on a scale four times as great, and by giving to the stars much smaller discs to exhibit the nebula more nearly free from stellar blurring.

Careful examination will bring out many interesting features. I think the following are all that need be noted now:—

First, the swan-neck of Herschel's drawing, which is just hinted at in the Gill photograph (No. 5), is here very feebly but unmistakably visible. The change, therefore, if change there has been in the nebula since the days of Herschel's observation, has been probably one, not of shape but of relative brilliancy; and this, I think, is easier for us to understand.

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Second, the faint, dusty areas that can just be discerned, especially in the south of Dr. Gill's photograph, and which might easily be conceived to be mere defects of the original negative or of its reproduction, are seen to be real nebulosity.

Third, there is a real correspondence between the convolutions of the nebula and the arrangement of the stars. This is seen in the way in which stars border the edges of the nebular rifts, and in which several "dark lanes," and the lines of stars which border and define them, radiate from the nebula, and conform themselves at starting to its outlines.

Lastly, we find other lines of stars and "dark lanes" which are not thus associated with the nebula. More than one crosses it without either affecting the nebula or being affected by it; in particular one may be noticed which runs from east to west, just south of the "keyhole" nebula, and which passes right across the northern part of the southern nebula. Then, again, other "lanes" may be noted running their course north or south of the nebula, and bearing no relation to it. Clearly we have at least two independent structures here, at different distances from us, and simply brought into association by their projection in the line of sight. Probably both are Galactic, and we here see superposed two folds of the Galaxy, the real Mitgard snake that embraces the universe. Whether the nebula is in the nearer or the further fold we cannot yet determine.

THE SUPERSTITIONS OF SHAKESPEARE'S GREENWOOD.

By George Morley, *Author of "Leafy Warwickshire," etc.*

IF it is remarkable—and I think it is—that the dialect form of speech now in vogue in rural Warwickshire should have survived for a period of between three and four hundred years, it is also noteworthy that the superstitions should have existed for a like term, and should still survive in some of their most famous forms at the end of the nineteenth century, in an age which plumes itself upon its civilization and enlightenment. This is the more remarkable bearing the fact in mind that Warwickshire is the central county of England, open to all the influences of modern civilization, and in many seasons of the year simply overrun with visitors, who may be supposed to bring with them the new ideas, the new fancies, and the new language of a new people.

The survival of superstition is, I think, to be traced to the original woodiness of "leafy Warwickshire," which made it a dark land in which Nature could play her many moods both night and day; and these would, no doubt, operate strongly upon the minds of the simple, almost primeval, woodlanders with an energetic and perhaps a fatal effect; because people who are cut off, as it were, from all civilizing influences are more prone than townspeople to regard the movements of natural life as evidences of the supernatural, and to associate with an invisible and evil agency the simple workings of the laws of Nature. Yet the curious fact remains that the most famous survivals of superstition in Warwickshire have occurred in the Vale of the Red Horse, which lies in the Feldon, or "open country," south of the Avon; whereas the woodland, which embraces the ancient Forest of Arden, is on the north of the river; and although superstition in many forms is rife there to-day, the more celebrated cases are indigenous to the soil of the south, growing out of Shakespeare's own immediate neighbourhood, and are perhaps to be traced to the proximity of the Rollright Stones, on and around which so much superstition continues to cling.

What I may call the gentler forms of superstitious feeling are common to both woodland and Feldon. The forester, the ploughman, the milk boy, the field girl, the housewife, and indeed all peasants of whatever age, condition, or calling, will turn their money—if they have any; if not they will borrow two halfpence for the occasion—"for luck" at hearing the first note of the cuckoo. The waggoner, returning home to his cottage in a combe on a summer evening after a hard day's work, would feel uneasy in mind if *one* magpie instead of *two* flew over his head. He would persuade himself that sorrow was in store for him. In his simple country jargon—

> "One magpie means sorrow; two mirth;
> Three a wedding; four a birth."

So when he saw the one magpie—the fateful one—he would cross himself or raise his hat to it, to prevent the "bad luck" which would otherwise follow.

Such forms of superstition as these, and many others to which I shall presently allude, are peculiar to the peasants in all the villages and hamlets of Warwickshire; so far, however, as an intimate knowledge of the life of the peasants has enabled me to discover, it is only in the Vale of the Red Horse, and more especially in the immediate vicinity of the villages of Kineton, Tysoe, and Long Compton, where superstition, amounting to an unslayable belief in witchcraft, has existed in an acute form during the past twenty years, and still survives in spite of the march of education.

Perhaps the surroundings of the village of Long Compton have something to do with the survival there to this day of a staunch belief in witchcraft. It is just on the southern border-line of "leafy Warwickshire," is planted in a gentle hollow, and is quite close to the King Stone of the Rollrights. The community, too, is extremely small, and is practically untouched by the enlightening influences of modern progress.

In September, 1875, there were in the opinion of James Heywood, a dweller in the locality, no less than sixteen witches in the village of Long Compton. The man was not singular in his opinion; many others shared the same extraordinary belief, though they were more passive in their actions than Heywood. In the same village there had lived from her birth to the age of eighty a woman of the peasant class named Ann Tennant. By some means the poor old lady had drawn upon her the unwelcome attentions of certain villagers, who, led by the modern Warwickshire witch-hunter, James Heywood, and filled with the superstition of the neighbourhood, became firmly convinced that she had the evil eye and was a "proper witch."

No doubt the man, ignorant boor though he was, had imbibed some knowledge of witches and of the manner of testing them. It is clear, indeed, that he had determined to test, or rather to kill, Dame Tennant, for, chancing to meet her out one day gathering sticks for the coming winter, he stabbed her with a pitchfork, and so severely that the wound proved fatal, and the poor victim of deeply-seated superstition died almost immediately.

How surely the cloud of superstitious belief had fallen upon the mind of this man was shown in the defence he made for the murder he had committed. "If you knows," he said, "the number o' people who lies i' our churchyard, who, if it had not been for them [the witches], would be alive now, you would be surprised. Her [the deceased] was a proper witch." His mind was thickly overlaid with supernaturalism. He saw witches everywhere—in everything. When water was brought to him in the police cell he roundly declared that there were witches in it.

Heywood's method of attacking the supposed witch was evidently a survival of the earliest and most famous style of superstitious incantation of the Anglo-Saxons, called "stacung" (or sticking), which consisted in sticking spikes, pins, or thorns into the detested person, with the expression of a wish that the wounded part might mortify or wither away. In most parts of England where a belief in witchcraft has existed, this has been the form which the testing has taken, though in some instances, as Sir Walter Scott states, clay images of the detested person were made and stuck over with pins or spikes.

The year 1875 was quite a witch year in the Vale of the Red Horse. All the little lonely villages, clustering there in silence and suspicion, were bitten by the craze for witch finding. Whether Long Compton started the cry or not cannot well be determined, but it passed mysteriously from village to village and made a very sad time for ancient dames. One such suffered at the village of Tysoe, a short distance from Long Compton. She was reputed by her neighbours to be a witch, so much so that some people came over from Brailes, an adjacent village, and, taking her unawares, scored her hand with a corking pin, in order, as they said, to nullify the effects of the evil eye she had cast upon them.

To draw blood was always the favourite method of dealing with supposed witches. That there were persons thought to possess the power of witchcraft in Warwickshire, and that blood was drawn from them, three hundred years ago, may be assumed from the fact that Shakespeare alludes to the practice in the first part of "King Henry VI." when he makes Talbot say to La Pucelle:

> "Blood will I draw on thee: thou art a witch;
> And straightway give thy soul to him thou servest."

It is an interesting though painful fact, therefore, to notice that blood should have been drawn from a supposed witch in Shakespeare's own neighbourhood so recently as the year 1875.

Superstition in Warwickshire has from a very early period associated itself with a staunch belief in the appearance of the "night coach." This is a form of vision-seeing quite peculiar to woody districts, and similar to the spectral apparition of "the boggart," which was formerly asserted to be so often seen in the neighbourhood of Meriden—anciently called the "Miry Den," because of its swampy condition—which is seated in the thick portion of the once famous Forest of Arden.

A "night coach" is recorded to have nightly ridden over the flats and hills in the district of the villages of Mickleton, on the Gloucestershire border, and Ilmington, within the boundary lines of "leafy Warwickshire." Many people staunchly averred that they saw this phantom coach, and even to this day the memory of it remains deeply rooted in the minds of the old and solitary inhabitants, the uncanny story having been told to them by their superstition-enthralled ancestors. This coach has been described by those who professed to have seen it as a heavy family coach, at that date—somewhere about 1780—grown old-fashioned, and drawn by six dark horses. Its course was over the springy turf of the hills towards the Gloucestershire boundary of the county, whence it passed abruptly over the brow of the steep hills into the deeps beneath, in a manner which never could have been accomplished by an earthly coach, drawn by six natural horses, and driven by a natural coachman. I am sometimes disposed to think that there may be traced some connection between this "night coach" and the famous spectral six-in-hand of the equally famous Elizabethan knight, One-handed Boughton, of Lawford Hall, near Rugby, in the north-west district of Warwickshire, as this coach appeared about the same date, and made its excursions during the nocturnal hours, which was of course quite natural in a phantom coach.

What the particular cause of the nightly racings of One-handed Boughton was, cannot precisely be determined; but that his spirit was by some means violently exercised, and that men of light and leading firmly believed in the apparition, may be assumed from the fact that several Warwickshire gentlemen and clergymen met together one night when One-handed Boughton was taking his nightly ride, and by bell, and book, and prayer, succeeded in catching his perturbed spirit, and enclosed it in a phial, which they threw into a neighbouring marl pit filled with water.

As showing the grip which these old-time superstitions have upon the mind of the Warwickshire rustic—though I must confess that there is something mysterious and unexplainable in this case of One-handed Boughton, and am reminded of the speech Shakespeare puts into the mouth of Hamlet: "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy"—it may be of interest to note that in the early "seventies," though the old hall at Lawford had long since been razed to the ground, there was a revival of the belief in the ghostly visitation of One-handed Boughton, and it exists to this day in the vicinity of Rugby.

One instance among several was afforded by a Mr. John Watts, an old and respected inhabitant of Rugby, who died about the year 1868, aged ninety-three. He was, it is said, one day out walking with a friend in the neighbourhood honoured by the appearance of One-handed Boughton, when the friend suddenly started, and, pointing to a distance, cried, "There is One-handed Boughton!" Mr. Watts averred that he stared with all his might in the direction indicated, but *he* could see nothing whatever.

It is probably owing to the still leafy and undulating condition of Warwickshire that so many of the current superstitions have become connected with outdoor life. There are strong beliefs in haunted houses, and it would be strange if there were not in a country so rich in historic mansions, each of which has its own particular romance, and many of which have their own familiar spirits; but where the superstitious hold upon the peasant mind is greater is in the vicinity of ancient fabrics whose character is shadowed by some grim story that has come down through the ages, where some dark deed of bloodshed committed in the past has woven a cloud of superstition and fear, which generally results in the so-called "appearance" of a ghostly visitant to some of the rustics.

Thus we find, and not unnaturally when the romance and history of the place is recalled, that the spirit glamour has settled down upon the ancient seat known as Guy's Cliffe—one mile from Warwick by the Coventry road—now the residence of Lord Algernon Percy, son of the Duke of Northumberland; and also over Blacklow Hill, a slight eminence a little distance north-west of the Cliffe.

This very picturesque house, charmingly seen at the end of a venerable avenue of Scotch firs, is, as every reader of English and Warwickshire history is probably aware, the scene in which is laid the romantic story of Guy, Earl of Warwick, whose exploits in love and war form a subject which, if mythical, as antiquarians declare, has nevertheless developed into a belief which centuries have not removed, and which no amount of antiquarian discussion can exorcise. Blacklow Hill is the historic spot upon which the witty and unscrupulous Gaul, Piers Gaveston, Earl of Cornwall, and favourite of Edward II., lost his head at the instigation of Guy de Beauchamp, Earl of Warwick—called by Gaveston "the Black Dog of Arden"—

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and other powerful barons: so that the survival of superstitions in and around this spot is, as I have said, not unnatural.

Hard by Blacklow Hill there is a tract of waste land called Ganerslie Heath. No peasant will linger there after nightfall, for strange sounds are said to be heard issuing through the thick foliage. At the dread hour of midnight it is averred that dismal bells toll from Blacklow Hill, and as the palfrey upon which Gaveston was led to execution there was richly caparisoned and wore a string of bells round its neck, superstition has come to regard this sound as proceeding from the spectre of man and horse, which, during the past five hundred years, is supposed to have traversed the road from Warwick Castle to the place of execution, just as the gruesome cavalcade did in real life upon that doomed midnight or early morning.

A curious superstition, which amounts to the firmest belief, surrounds a structure called Littleham Bridge, a lonely spot on the high road between Hampton Lucy and Stratford-on-Avon. Here, on the night of the 4th of November, 1820, Mr. William Hirons, a yeoman of the neighbouring village of Alveston, was set upon and murdered by four ruffians. He was found dead in the morning, with his head resting in a hole, and from that day to this, a period of seventy-five years, every attempt to fill the hole again has, it is said, been ineffectual. This is the local belief and affirmation. If the hole is filled with earth at night, it is empty again the next morning. What strange being or power performs this nocturnal act, no man knoweth; but that it is a foundation of the very deeply rooted superstition can be ascertained by anyone who visits the spot, and inquires about the tragedy and the hole from the inhabitants of the locality.

The two stories connected with the Ladies Charlotte and Margaret Clopton—both of which must have been known to Shakespeare, the first of which he is thought to have utilized in "Romeo and Juliet," and the other in "Hamlet"—are of a character so romantic and lamentable that it is no wonder they should have added the phantom touch to the old edifice; both ladies, indeed, have enjoyed the reputation of having "walked" in spirit about the house and grounds of their home ever since their untimely deaths, more than three hundred years ago. The scene of Charlotte Clopton's tragic story is laid at Stratford-on-Avon Church during the black plague, which greatly decimated the population of the classic town in 1564, and which, no doubt, was the means of many persons being buried alive in Warwickshire. In his "Visits to Remarkable Mansions," William Howitt alludes to the story in the following words:—"In the time of some epidemic, the sweating sickness or the plague [the black plague], this young girl sickened, and, to all appearances, died. She was buried with fearful haste in the vault at Clopton Chapel, attached to Stratford Church, but the sickness was not stayed. In a few days another of the Cloptons died, and him, too, they bore to the ancestral vault; but as they descended the gloomy stairs they saw by the torch-light, Charlotte Clopton, in her grave clothes, leaning against the wall; and when they looked nearer she was indeed dead, but not before, in the agonies of despair and hunger, she had bitten a piece of flesh from her white round arm. Of course she has 'walked' ever since."

If in the case of Charlotte Clopton there are mythical elements which throw doubt on the actuality thereof, it is not so with regard to the mournful fate of Margaret Clopton, whose story Shakespeare has made use of in "Hamlet," the fair Margaret being thought to be the prototype of the gentle Ophelia. This young and beautiful lady, having fallen in love with a man of whom her parent, Sir William Clopton, disapproved, and being forbidden the society of her lover, sought the only method of escape from a painful thraldom which seems open to love-sick maidens. "Too much of water hast thou, poor Ophelia," said the troubled Laertes; and the same might be said of Margaret Clopton, for, being wrought up to agony point, she drowned herself in a pond in the grounds of Clopton House, which is shown you to-day, and the legend runs that the fair young lady's spirit still haunts the scene in the silent watches of the night.

The gentler superstitions of rural Warwickshire, as I called them at the beginning of this article, are many and various, and deal, perhaps, more with outdoor than indoor life, though the preternaturalism of cottage life is very strongly marked. That old superstition connected with the wych elm—of which there are so many in Warwickshire—seems to be as firmly planted as ever in the minds of the rustics. There is an account current of a gentleman who a short time ago went to live in a remote part of the country. Having cut down a wych elm, he told some of his workmen that they could have the branches for firewood. In the course of a week or two he noticed that none of the wood had been removed, and asked the reason. "Why, mister," was the reply, "we donna want the old 'ooman amongst us, to be sure." Upon questioning them it appeared that it was a general belief that to burn wych elm would bring down the malignant powers.

Superstitions regarding birds are very extensive in Warwickshire and very steadfastly entertained. The cuckoo during the winter is changed by rustic faith into the sparrowhawk; the yellowhammer is supposed to drink three drops of the devil's blood each May morning; and the robin is believed to have scorched its breast with hell fire, near which it had ventured for a beakful of water. There is also another and far more tender superstition attached to the robin which is faithfully held by village folk of religious inclinings; it is to the effect that the robin crimsoned its breast in administering to the needs of our Saviour when on the cross.

With this, the prettiest and tenderest of all the superstitions at present in vogue in Warwickshire, I bring this paper to a conclusion. The subject is one that is surrounded with the deepest interest, inasmuch as the bent of rustic feeling in this delightful county towards a belief in the supernatural is, as I have attempted to show, almost as strongly marked to-day, in spite of the wide-reaching influence of civilization and education, as it was in the days of Shakespeare; though in his time the aspect of Warwickshire was more calculated to inspire the mind with eerie feelings than it is now.

WHY DO YOU PHOTOGRAPH?

By T. A. Gerald Strickland, F.E.S.

WHY do you photograph? is a question that numbers of amateurs would have a difficulty in answering satisfactorily. Is it to expose quantities of plates on "pretty bits," or on "evenings," or "sunrises," the titles of which would be suitable, in the majority of results, to either print, and no one be any the wiser? Or is it for the pleasure of developing dozens of negatives, of which about ten per cent. are printed? And even when they are printed, what then? Have you become an "artist"? But this is dangerous ground! I had better say at once that my knowledge of Art (with a capital "A") is very limited, and the vexed question of the "artistic capabilities of photography" had, therefore, better be avoided.

I suppose no process has made such rapid progress as photography since the discovery, by Daguerre, of his invention known as "Daguerreotype," in the thirties; and as an aid to science it is becoming more and more useful every day. In natural history subjects we have, indeed, some very fine workers amongst us. Look, for instance, at the photographs of animals, botanical subjects, and birds, by Gambier Bolton, Henry Sandland, Henry Troth, Mrs. Carine Cadby, R. B. Lodge, and others.* The field naturalist is now greatly increasing his interest and knowledge by the use of the camera.† "Natural history is no work for one who loves his chair or his bed. Speculation may be pursued on a soft couch, but nature must be observed in the open air. I have collected materials with indefatigable pertinacy. I have gathered glow-worms in the evening and snails in the morning. I have seen the daisy close and open. I have heard the owl shriek at midnight, and hunted insects in the heat of noon." So says Johnson. Now, if amateur photographers would only follow in the footsteps of these earnest workers, and have some *aim* in view when out with their cameras, how much more lasting would their interest in photography become, and what might not be the gain to science!

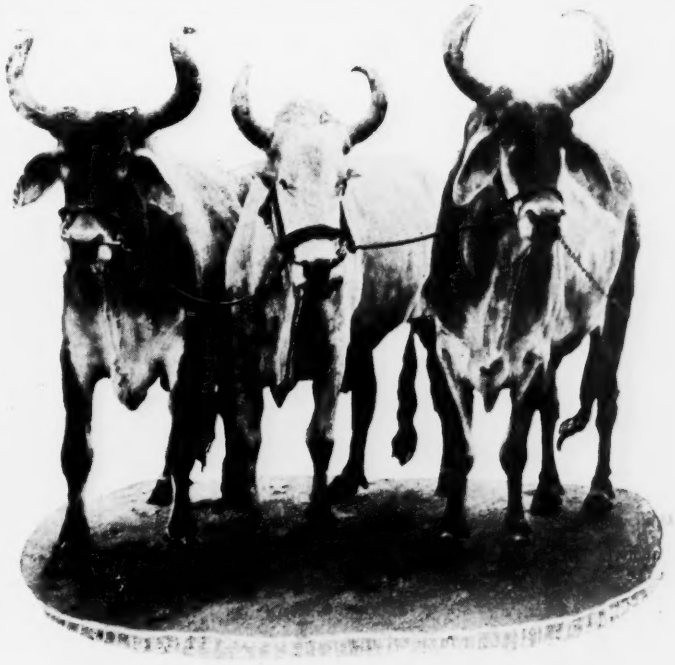
For photographing animals it is necessary to have a thoroughly good lens of long focus and working at as large an aperture as possible. The one I principally use is of fourteen-inch focus, and has a working aperture of F. 5·6. This I work on a whole-plate camera. In taking the animals at the Zoological Gardens, I find them, as a rule, so tame that a very short exposure is seldom necessary.‡ For nervous animals, such as deer in parks, a hand camera is more suitable.

One would think all that could be said about hand cameras and how to use them had already been published; but, judging from results that we are shown, with the remark, "I don't think it is so bad considering it was done with a hand camera," all that has been written has not been digested. Now, the phrase, "considering it was done with a hand camera," is no excuse for bad results, as, with command of the instrument, certain subjects are more easily and satisfactorily taken with that class of apparatus than with a stand camera. I think the failures are the result of giving much too short an exposure, of trying to take unsuitable subjects, and of not using the lens with as large an aperture as possible for single or near objects. The development of the plate has also a great deal to do with some of the failures. I fancy most people, when they first purchase a hand camera, think the whole theory of using them is totally different from stand camera photography, and that, in some extraordinary manner, subjects that would require about five seconds' exposure with a camera on a tripod can be taken perfectly well in one-fiftieth of a second if the camera is held in the hand! If you venture to remonstrate, they say, "Oh! but this is the instantaneous process, you know." Because you have a shutter that can work in one-hundredth of a second is no reason that you should always use it at that speed.

The generality of snap-shots can be taken quite satisfactorily in one-tenth of a second if the subject is not too close. A higher speed than one-twentieth I find is very rarely required; and with regard to not shaking the camera during exposure, that is simply a matter of practice. An exposure of one second can quite well be managed, and even longer if the camera is pressed against something solid, such as a gatepost or tree trunk. The hand camera is not intended to take architecture or interiors, unless used on a stand; and, though it is not necessary for the sun to be shining, the light should be fairly actinic, and, if possible, the subject well lighted. The lens can be used at full aperture, as, if it is a good one (which is a *sine quâ non* for this kind of work), it is only necessary to use a smaller diaphragm to obtain what is known as depth of focus; and as taking an animal is practically portraiture, this is not required, and a shorter exposure can be given, if the beast is restless, without hopelessly under-exposing the plate. I think most of the hand cameras on the market are good enough of their kind, but, personally, for animals, I prefer one of the full-sized finder and twin-lens type, and I have used six or seven different sorts during the last eight years. Most people will swear by the kind they happen to use, and this, of course, is as it should be.*

The telephotographic lens would also be useful for shy animals or birds, that will not allow a close approach.†

". . . . The photographer has now at his command a lens" (the telephotographic lens) "which needs a camera



Indian Zebus in the Zoological Gardens. From a Photograph by Mr. T. A. GERALD STRICKLAND.

* *See* two very interesting illustrated articles entitled "Among the Sea-Birds," in the *Badminton Magazine* for November, 1895, and "Sea-Birds at Home," in the *Windsor Magazine* for November, 1896, both by Mr. R. B. Lodge.

† *See* article by Harry F. Witherby in KNOWLEDGE for October, 1895.

‡ *See also* "Notes on Animal Portraiture," by W. Girling, in the *British Journal of Photography Almanack* for 1896; "Photographing Bats," by S. R. Stoddard, in the *American Annual of Photography* for 1890; and also "Zoophotography," by Lewis Medland, in the *British Journal of Photography Almanack*, 1894.

* *See also* "The Hand Camera and How to Use It," by W. D. Welford.

† *See* "The Telephotographic Lens," by T. R. Dallmeyer, F.R.A.S.

but two feet in length, but which will, under such conditions, give an image of the same size as if he were using a lens of one hundred inches focal length. In all previous attempts in this direction it has been the custom to get a primary image and then to magnify it, but in the case before us the primary and greatly enlarged image is itself projected on the focussing screen." * The following may also be of interest to ornithologists: "We have seen the instrument, and specimens of work done by it, one being an instantaneous picture of a crow about to settle on the top of a tree one hundred yards distant, the bird measuring on the picture three-quarters of an inch from tip to tip of his outspread wings." †

Marabou Stork in the Zoological Gardens. From a Photograph by Mr. T. A. Gerald Strickland.

The botanist can also find many uses for photography, if carried out systematically. ‡ The entomologist also finds it a useful handmaid; it can also be of invaluable assistance to anthropologists.§ Then, again, there are so many trades and crafts that can be traced through, from the primitive state of the material used to the finished article. To give an instance: why not take iron, and work it through with a careful series of prints, from "the ore to the horseshoe"?

It is to be regretted that more amateurs do not take up photomicrography. What unknown worlds the microscope has opened up to science of all sorts! Doctors, bacteriologists, and many others would be hand-tied without it, and in numbers of cases I believe photomicrographs to be more satisfactory and certainly quicker than drawings. "The potential value of photography in this line has always been admitted and often dwelt upon; but difficulties, some real, some exaggerated, some imaginary, have always been cited as fatal to the employment of photography for the delineation by a graphic method of microscopic images."‖ Photomicrography brings us to surgery, where a large field is open for photography. "In the surgical rooms of our large hospitals and infirmaries photography is rendering invaluable aid in the proper treatment of medical operations. For upwards of a quarter of a century photographic records of deformities, dislocations, tumours, and operations have been systematically produced, which have had the merit of demonstrating the advantage or disadvantage of different methods of treatment, the *raison d'être* of certain modes of procedure, and the chronicling of mistakes and successes that have served as guide or warning in future cases." * "Radiography" I will not touch upon, for, in the words of Captain Abney (annual address at the Royal Photographic Society, 1896): "I am purposely excluding photography by the X rays as being anything belonging to an advance in photography. It is not a new photography, but the old kind, and its claim to novelty belongs more to electrical than to photographic science." At all events it is not "pure" photography, as no camera or lens is required. By "pure photography" I mean the work that can be achieved by the apparatus likely to be in the possession of the ordinary amateur.

Now, supposing that the photographer is not scientifically inclined, there is still architecture, character studies, and photographic survey † to be worked up as a useful aim. I would suggest a series of Norman doorways or Norman windows—also porches, cloisters, or crypts. But anyone taking up this branch should not fail to read the Rev. T. Perkins' "Chapters on Gothic Architecture," in *Amateur Photography* for 1894-5. Then a series of photographs of the houses of eminent persons might be made. They will become of great interest presently, as the houses are being swept away by the ruthless hand of the "improver," one by one. The illustration of scientific works, or even novels, such as Mr. Symonds' "Malvern Chase" or Kingsley's "Westward Ho!" would give an object for the usual tour.

For printing natural history subjects or photomicrographs I know nothing better than carbon or gelatino-chloride paper. The latter should be *squeegeed* on to ferrotype plates to give it a gloss that brings out the detail, which is what we want for this sort of thing. With regard to the illustrations of the Indian zebus and the Marabou stork, I should like to say that I am indebted to an article in the *Amateur Photographer* for the idea of giving them the appearance of standing on a slab of stone. To block out the whole background of the negative, if it is unsuitable, is an advantage.

The blocking-out medium I use is simply sepia (moist water colour) thinned to the consistency of cream with ordinary black writing ink, and carefully applied to the negative with a camel's-hair pencil.

These little details are of importance to the earnest worker, for "there is *nothing* insignificant—*nothing*." Look at photography as a means to an end, not as the end itself. Work systematically, have an aim, and keep your failures. You will find them of use to refer to. A failure is often of more value than many text-books. Photographers should find out what they really have a turn for, and specialize that, for they must remember, "Nothing is really well done which it costs you pain to do."

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* "A New Lens," in the *Photographic News* of October 16th, 1891

† "On Photographing Distant Objects," in the *Optician* of October 15th, 1891.

‡ *See* "A Visit to Kew Gardens," by J. H. Baldock, F.C.S., in the *British Journal of Photography Almanack* for 1897.

§ *See* "Ethnographic Photography," by M. V. Portman, in the *British Journal of Photography Almanack* for 1896; also "Photography for Anthropologists," by M. V. Portman, in the *Journal of the Anthropological Institute* for August, 1896; and "Photography in Anthropological Work," by Prof. Fred Starr, in the *American Annual of Photography* for 1893.

‖ "Practical Photomicrography," by Andrew Pringle, F.R.M.S., 1890. Those interested in this branch should also see Van Heurck's work, "The Microscope"; and the "Outlines of Photomicrography," by Andrew Pringle, in the *Photogram*.

* "Photography as an Aid to Study," by Richard Penlake, in the *British Journal of Photography* for 1896; *see also* "Photographing Surgical Specimens," by A. S. Murray, in the *American Annual of Photography* for 1893.

† *See* "A Plea for a Survey of Life and Character," by Hall Edwards, L.R.C.P., in the *British Journal of Photography Almanack* for 1896.

THE FACE OF THE SKY FOR MAY.

By HERBERT SADLER, F.R.A.S.

SOME fair-sized groups of sunspots have recently appeared on the Sun's surface.

Mercury can be observed as an evening star during the first third of the month. On the **1st** he sets at 9h. 31m. P.M., or 2h. 10m. after the Sun, with a northern declination of 23° 5′, and an apparent diameter of 8½″. On the **7th** he sets at 9h. 20m. P.M., or 1h. 50m. after the Sun, with a northern declination of 23° 4′, and an apparent diameter of 10″. On the **11th** he sets at 9h. P.M., or 1h. 25m. after the Sun, with a northern declination of 22° 21′, and an apparent diameter of 10¾″. After this he approaches the Sun too nearly to be visible. He is in inferior conjunction with the Sun on the **20th**. While visible he describes a short direct path in Taurus to the north of the Hyades.

Venus is too near the Sun to be well observed during the first half of the month. On the **21st** she rises at 2h. 51m. A.M., or about 1¼ hours before the Sun, with a northern declination of 11° 45′, and an apparent diameter of 47″. On the **31st** she rises at 2h. 27m. A.M., or about 1h. 23m. before the Sun, with a northern declination of 11° 1′, and an apparent diameter of 40″. While visible she describes a short direct path through a portion of Aries, barren of naked-eye stars.

Mars can be observed during the first half of the month, but he is rapidly becoming a very insignificant object for telescopic scrutiny. On the **1st** he sets at 1h. 11m. A.M., with a northern declination of 23° 38′, and an apparent diameter of 5⅓″, the phasis amounting ⅓″. On the **14th** he sets at 0h. 40m. A.M., with a northern declination of 22° 14′, and an apparent diameter of 5¼″. During this time he pursues a direct path in Gemini to the borders of Cancer.

Jupiter is an evening star, setting on the **1st** at 2h. 43m. A.M., with a northern declination of 12° 33′, and an apparent equatorial diameter of 40″, the phasis on the *f* limb amounting to ⅓″. On the **15th** he sets at 1h. 50m. A.M., with a northern declination of 12° 20′, and an apparent diameter of 38½″. On the **31st** he sets at 0h. 48m. A.M., with a northern declination of 11° 50′, and an apparent equatorial diameter of 36¾″. During May he describes a short direct path in Leo, somewhat to the east of Regulus.

Saturn is an evening star, rising on the **1st** at 8h. 37m. P.M., with a southern declination of 17° 39′, and an apparent equatorial diameter of 18″ (the major axis of the ring being 43″ in diameter and the minor 17¾″). On the **15th** he rises at 7h. 36m. P.M., with a southern declination of 17° 26′, and a diameter of 18″. On the **31st** he rises at 6h. 27m. P.M., with a southern declination of 17° 11′, and an apparent diameter of 18″. During the month he pursues a retrograde path in Libra. He is in opposition on the **18th**.

Uranus is an evening star, but is even worse placed for observation in these latitudes than Saturn is. On the **1st** he rises at 8h. 41m. P.M., with a southern declination of 19° 26′, and an apparent diameter of 3·8″. On the **31st** he rises at 6h. 36m. P.M., and souths at 10h. 58m. P.M., with a southern declination of 19° 9′, and an apparent diameter of 3·8″. During May he describes a short retrograde path in Scorpio, not far from β Scorpionis.

Neptune is practically invisible.

There are no very well marked showers of shooting stars in May.

The Moon is new at 8h. 46m. P.M. on the **1st**; enters her first quarter at 9h. 37m. P.M. on the **9th**; is full at 1h. 54m. P.M. on the **16th**; enters her last quarter at 9h. 34m. A.M. on the **23rd**; and is new again at 0h. 26m. P.M. on the **31st**.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of April Problems.

No. 1.

(By P. H. Williams.)

Key-move.—1. K to Q2.

If 1. . . . K to B3, 2. Kt to B3.
1. . . . K to K4, 2. Q×P.

No. 2.

(By A. C. Challenger.)

1. R to KB3, and mates next move.

CORRECT SOLUTIONS of both problems received from Alpha, W. J. Ashdown, F. Wilhelmy, E. W. Brook, H. H. Thomas, Captain Forde, J. T. Blakemore.

Of No. 2 only from G. G. Beazley, A. P. Hyatt, W. H. Lunn, W. Clugston, J. M'Robert.

Rev. F. W. Quilter, D.D.—Your solutions last month were quite correct, but a week too late to acknowledge.

H. D'O. Bernard.—The sacrifice offered in your game has the merit of soundness, usually absent from this particular sacrifice; but it occurs so often that there would be little use in publishing it. Why 11. QKt5ch? P×Kt, threatening to win a Pawn by the check, and to Castle QR would give White a most desirable open file.

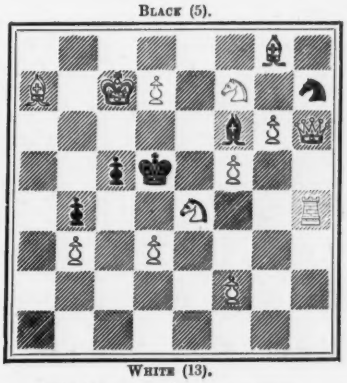
W. J. Ashdown.—Nos. 2 and 3 are selected as having the better key-moves.

PROBLEMS.

By W. J. Ashdown.

No. 1.

BLACK (5).

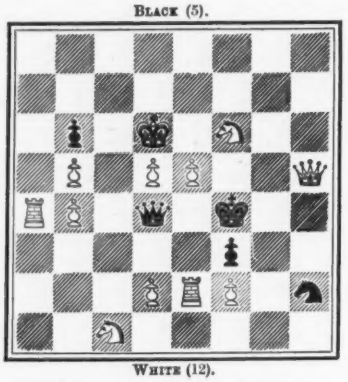


WHITE (13).

White mates in two moves.

No. 2.

Black (5).



White (12).

White mates in two moves.

CHESS INTELLIGENCE.

The Pillsbury-Showalter match continues to be most evenly contested. The score last week was six all with three draws, a state of affairs which, according to the terms of the match, necessitated its prolongation to ten games. Both players have consistently (to quote from "Q.'s" ballad) "stuck to the old Ruy Lopez and wondered who'd call for trumps"; but Mr. Pillsbury produced his trump card in the sixteenth game, a Queen's side opening, and gained the lead thereby.

M. Tchigorin is engaged in a match with M. Schiffers, and holds a commanding lead in the score.

Mr. Steinitz has now apparently quite recovered, and has been playing simultaneously at Vienna with his usual success. He returns to New York shortly.

Mr. T. F. Lawrence has won the championship of the City of London Chess Club for the second year in succession. He disputes with Mr. E. M. Jackson the claim to be considered at the present moment the best London player.

The Inter-University Chess Match resulted in a win for Oxford by 4 games to 3. The match score now stands at—Cambridge, 15; Oxford, 9; drawn, 1. The score reckoned in games is less disproportionate:—Cambridge, 118; Oxford, 100; drawn, 58.

The game played on Board No. 1 is appended. We recognized the strength of Mr. Spencer Churchill's play in the game published in this column last year. The score was as follows:—

Oxford.		Cambridge.	
1. E. G. S. Churchill (Magdalen)	1	1. E. A. Crowley (Trinity)	0
2. E. Lawton (Corpus)	1	2. W. F. Naish (Emmanuel)	0
3. R. A. Jenkins (Brasenose)	½	3. R. Battersby (St. Cath.)	½
4. G. Fraser (Corpus)	0	4. C. E. C. Tattershall (Trinity)	1
5. A. H. W. George (New Coll.)	0	5. L. M'Lean (King's)	1
6. G. H. Stokes (Corpus)	1	6. A. L. Stainer (St. Cath.)	0
7. R. Hancock (Exeter)	½	7. A. Fotheringham (Emmanuel)	½
	4		3

"Petroff's Defence."

White. Spencer Churchill (Oxford).	Black. E. A. Crowley (Cambridge).
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to KB3
3. Kt × P	3. P to Q3
4. Kt to KB3	4. Kt × P
5. P to Q4	5. P to Q4
6. B to Q3	6. Kt to QB3
7. P to B3	7. B to KKt5
8. P to KR3	8. B to R4
9. B to K3	9. B to Q3
10. QKt to Q2	10. P to B4
11. Kt to Kt3	11. Q to K2
12. Q to K2	12. P to B5
13. B to Q2	13. B × Kt
14. P × B	14. Kt × B
15. Q × Qch	15. Kt × Q
16. K × Kt	16. Castles QR
17. QR to Ksq	17. QR to Ksq (?)
18. R to K6	18. Kt to B3
19. R × Rch	19. R × R
20. B × P	20. P to QKt3
21. R to KKtsq	21. R to K2
22. B to Kt8	22. Kt to Qsq
23. B × P	23. P to B3
24. B to K4	24. K to B2
25. K to Q3	25. Kt to K3
26. Kt to Q2	26. P to QB4
27. P to Q5	27. Kt to Bsq
28. Kt to B4	28. P to QKt4
29. Kt × B	29. K × Kt
30. P to Kt3	30. Kt to Q2
31. R to Kt6ch	31. K to B2
32. P to Q6ch	32. Resigns.

KNOWLEDGE, PUBLISHED MONTHLY.

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Two Plates.—1. English Medals. 2. Photograph of the Great Nebula in Orion.

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